Paving and Municipal Engineering

VOLUME VI. JANUARY, EIGHTEEN NINETY-FOUR. NUMBER 1.

STATISTICS OF EXPENDITURES ON PAVEMENTS.

TOUCHING the past year's work and its lessons, I may venture to say that I have been more firmly convinced than ever of the great necessity of city engineers and boards of public works giving more attention to recording *analyzed* statistics of expenditures upon pavements. In order to profit by the past experience of their own cities, and reap the benefit of the work in other cities, and in justice to themselves and the tax-payers, they should analyze and tabulate the paving expenditures so that the following facts could at once be ascertained: The first cost of each pavement by streets; the kind of pavement, including foundations of concrete, gravel, sand, etc., by streets or parts of streets. Replacing an old pavement by a new one of the same kind is not a first cost, but is maintenance. Replacing by an improved kind—for example, asphalt instead of cobble-stone—is not to be charged wholly to first cost. Simply the difference in the cost of a new asphalt and a new cobble pavement is chargeable to first cost, because this increase is a new investment.

A pavement once on a street, is a plant, and if repaired or replaced, the original plant is simply kept in order and the original investment is not increased in value. If a pavement is neglected and wholly worn out, and is replaced by the same kind, this is simply maintenance all at once. It would have been better and more economical and to the advantage of the city to have kept the pavement in constant repair.

The *first cost* should be recorded under the headings of *cost of materials* and *cost of labor*, by streets or parts of streets; so that under

each kind of pavement, macadam, Telford, wood, brick, stone, asphalt, etc., we would see the cost of materials. A separate column would show the cost of labor by streets and kinds of pavements.

All records should be in square yards if not by "squares," as in St. Louis, and lineal feet of street, as in Brooklyn, because, while locally understood, they are not understood elsewhere, and this prevents that quick interchange of experience which is so profitable to all honest and progressive persons and places.

Under *cost of maintenance* we should find in all American cities that which is so easily had in European cities.

A city is a body with such a long life that the cheapest pavement is generally that which, at the end of a few years, ceases to drain the treasury by excessive maintenance.

Macadam is an excellent illustration of constant expense of maintenance if under city traffic, because whatever is done to it after the first year is maintenance.

Wood is another example of excessive maintenance, due to constant replacing or repairing, for we must remember to compare pavements by long periods of years, ten, twenty or more, and not by two, three and five-year intervals. The using of cheap, temporary pavements is seldom wise after a city has passed its babyhood and expects a future lasting prosperity. Money spent under the guise of repaving (maintenance it properly is) must not be constantly bled from a city and sent away. It takes years to get it back again. The *cost of maintenance* must be divided into *materials* for maintenance and *labor* for maintenance, if definite results are desired. This record of maintenance, if kept up fifteen years in a city, will show, conclusively, exactly what pavement is the cheapest and best for a city, and for each street in the city. A reference to these records of maintenance from other cities confirms home experience.

As to stone block pavement, for example, relaying old blocks up to grade, replacing worn with new, and the final replacing the entire surface with new blocks, is all maintenance.

The number of teams passing a certain place on a street in both directions (not an intersection) is called the "traffic record" of the

street. This number, divided by the width of the street, in yards, gives the average traffic per yard of width, and therefore over each square yard in the block where counted.

Thus streets can be compared by the square yard as to triffic, first cost and maintenance, as well as cost of cleaning, if desired. Also comparisons between the same kinds of pavements under different traffics are made. Manifestly, we must compare traffic by the square yard as well as first cost and maintenance, for streets of different widths mean different distribution of traffic, which means wear, and this means maintenance.

Finally, knowing the traffic and maintenance, we see at a glance what kind of pavement is suitable to various traffics, and what to use on certain streets or parts of streets.

Where new pavements are laid by contract it is possible to distribute this cost only to total first cost and total maintenance. Materials and labor items must generally be neglected. Tools worn out are best charged to materials. The part of the city office or administration expenses, due to paving in a city, should be distributed at the end of each financial year to paving, first cost and maintenance, by streets. This is easily done in a few minutes by an approximate estimate, the total of the charges being the total to be distributed.

If the law in each state and city was that the *first cost* of paving with a permanent pavement (not including macadam and similar wood surfaces) should be charged to the adjacent property, and *maintenance* (including repavements due to neglect to keep the original pavements in good order) should be paid from the common fund, then our cities would make better streets, and the paving problem would be nearer a solution. Each community would select that pavement which, while agreeable and fulfilling its business necessities, would cost the least to keep in constant good order for an indefinite number of years.

It does seem that a pavement once laid and paid for by adjacent property-owners is worn out by common traffic on a common highway, and should be maintained by common expense. On a street of heavy traffic we find very little of the traffic originating from

adjacent property of the street as a whole. It is the law in almost all European and a few United States cities to charge the first real pavement to the property and all maintenance, including repaving, to the general city expense.

J. W. HOWARD.
Biographical sketch in January number, 1893, page 6.

Moreover, in cities where owners of property intend to retain that property, it is best to suppress constant repaving with macadam, wood, etc., and use that which can be cheaply kept in constant order.

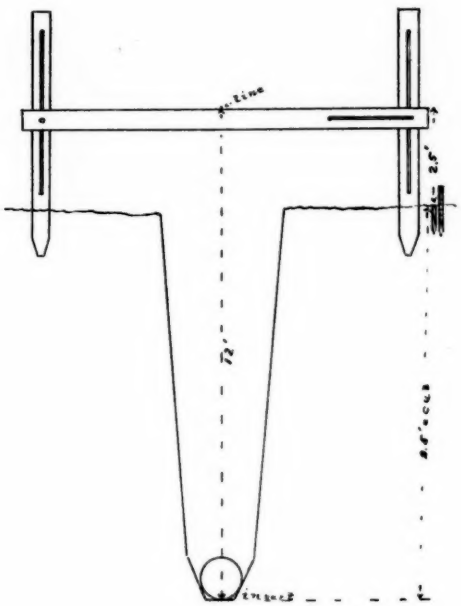
These thoughts are recorded as they come to me, and I regret that I can not take time to better arrange them. *J. W. Howard.*

HOW TO GRADE A SEWER.

THE line is first carefully located by setting stakes not more than twenty-five feet apart at a given distance from the center line of the sewer, say four to six feet, according to nature of soil and depth of the proposed trench. Now, on the side of each stake nearest the trench, drive a soiled "hub" on which levels are taken. From these levels, cuttings are carried out in the level book in the ordinary way, reserving one column beyond the "cuts," marked "*line heights*," in order to get the convenient heights from each hub that a line can be stretched, giving equal measurements above the established grade or invert of the sewer. Thus, if the sewer is from eight to nine feet deep, the cuts are successively subtracted from twelve feet, to get the height for the line at each station in order to use a twelve foot pole.

Procure two cross-bars and four standards made as follows, to wit: The standards shall be of inch hard wood boards, six inches wide, six feet long, sharpened at the foot for driving, and slotted with a one-half inch slot, from within six inches of the top to within eighteen inches of the bottom. The cross-bars should be ten feet long, five inches wide and one inch thick, and cut from white pine. A one-

half inch hole should be bored six inches from one end and a one-half inch slot, two feet long, extending to within six inches of the opposite end. Get four and three-eighths inch by three inch bolts, provided with two washers for each bolt. At station "0" drive one standard, and on the opposite side of the trench drive another. By means of the bolts, a wrench and carpenter's level, adjust the cross-bar on standards to the exact height shown in the "line height" column opposite "0," in the level book. Go to sta-



tion "1" and set the next pair of standards and cross-bar in a similar manner, and stretch a carpenter's chalk line from the top of the cross-bars at the proper distance from the staked line for the center line of the sewer. The line will now be the required height above the grade line of the sewer and parallel thereto. Have the measuring pole provided with a right-angle shoe for reaching into the invert of the sewer, and you have an outfit by which any intelligent inspector can secure the accurate grading of a sewer.

F. F. Rogers.

FRANK F. ROGERS was born August 30, 1858, in Holloway, Lenawee county, Mich. His education was obtained at the Agricultural College, Lansing, and the early part of his life was spent on his father's farm in Lenawee county. The first rudiments of schooling he received in common school and also at Rasin Valley Seminary, till, in 1879, he entered college and graduated from that institution in 1883. He immediately began the practice of surveying and engineering, and shortly developed a remunerative private practice. In May, 1891, Mr. Rogers was appointed city engineer of Port Huron. He is a member of the Michigan Engineering Society.

MACADAM PAVEMENTS ALONG ELECTRIC RAILWAY TRACKS.

THE past two seasons has been the beginning of what promises to become a complete revolution in material used in this city for street paving on residence streets. Previous to this season most, in fact nearly all, petitions received by our common council for street paving have called for a sapless cedar block pavement on a sand and board foundation, with or without cobblestone gutters. This season, a large percentage of the petitions for pavements have called for macadam. The stone generally accepted is a hard limestone quarried at Bay Port, Mich., on the S., T. & H. R. R., about fifty miles from Saginaw. This stone, as shown by tests made at the Watertown arsenal, is capable of withstanding a crushing load of 26,110 pounds per square inch before crumbling, or a load exceeding the average test of granite, as given by the best authority, by 1,110 pounds. Analysis shows that this stone would produce a fair quality of hydraulic cement. These two properties make it a very desirable stone for macadam paving. One petition was received for a macadam pavement on a street which is traversed by an electric street railway. The question now arose "can a macadam pavement be laid in streets traversed by electric cars and the portion of the street between and adjacent to the rails kept in safe condition for travel without a large expenditure of money for maintenance?" The experience in this city, on one street paved with macadam some six years ago, has been that soon after the street was opened to the public, depressions appeared on both sides of the rails, making it rather unpleasant and dangerous for persons driving on the street.

For this reason the petition was denied and the street was not paved. I have never heard the matter discussed to any extent, but have given it some thought on my own account, and have arrived at the following conclusion: That a street traversed by electric cars can be macadamized and the objectionable features above referred to remedied by a slight addition to the first cost of the pavement. My method of obtaining the desired result, unless something better were offered, would be as follows: The foundation of the track *must* be firm and solid. The rail used should be either a heavy groove or girder rail. The groove rail might be objectionable to the railway company before the top binding course had settled firmly into place, owing to small particles of stone and dust lodging in the groove. After the track is completed I should concrete around the rails and ties as shown in the following diagram.

In placing the macadam around the rails, care should be taken to use the best quality of stone, and only such stones should be used as approach the form of a cube in shape as nearly as possible.

The space adjacent to the web of the rails out to a line vertical with the head of the rail should be carefully filled with small fragments of stone, or better filled in with concrete as shown in the diagram. This method, which is nothing but a conclusion I have arrived at after some study, has never been tried in this city, but I think it would give satisfactory results.

I would like to make a few remarks regarding paving brick. It is the much discussed topic of "uniform hardness and quality of paving brick" that I have in mind. One street in this city which was paved with brick three years ago, being the first and only street paved with brick until this season, upon inspection shows several defective places caused by the accidental use of a few soft brick. In a short time these places will have to be repaired, and this will tend to turn public sentiment against brick as a paving material. Unfortunately I am not enough posted on the details of the manufacture of paving brick to suggest a method by means of which the de-

sired end could be accomplished, but if brick could be made of uniform quality and hardness it would aid their growth in public favor as a paving material. *Udo Hesse.*

SIDEWALK VAULTS.

In all large cities the space under the sidewalk is of great value to the abutting property-owner, especially so where large business buildings are erected. Usually a city ordinance allows the abutter to make use of the entire space under the sidewalk, from the building line to the gutter, under certain conditions.

This sidewalk space is a part of the public street reserved for use of the entire public, and should not be given up to private use without adequate recompense. The space under the surface of the street, in a large city, is used for a variety of purposes. Sewers, water pipes, gas mains, electric light and power wires, telegraph, telephone and fire alarm wires, pneumatic despatch tubes, steam heating pipes, compressed air pipes and refrigerating pipes, all have to make use of the underground space in the streets. Science and invention may devise other conveniences to be supplied from central stations, which will soon get to be considered almost as much of a necessity as water, light and sewerage now are.

Some city streets are already so fully occupied by such pipes and tubes that it is almost impossible to find space for any additional conduits. The space under the sidewalks is the most convenient location for the conduits of such semi-public corporations as supply these conveniences, on account of the facility for making connections as well as accessibility for inspection and repairs. For electric wires this space is especially valuable, as it can be kept comparatively dry, and thus avoid serious difficulties of insulation.

It is almost a necessity that some communication from the basement of a large building to the sidewalk should be had, and the value of a lot for business purposes would be seriously impaired if no sidewalk vault space could be used.

The writer would recommend that not more than one-half the width of the sidewalk be granted to an abutter in any case, and that the party desiring to use this sidewalk space be required to build a

solid masonry wall not less than six feet high along the middle line of the sidewalk, and another similar wall at the curb line, this space to be covered with suitable stone flagging and illuminated by sidewalk lights at frequent intervals; this work to be done by or at the expense of the property-owner, as compensation for the use of the vault space adjacent to his building. Thus would be provided a continuous vault area along the front of each block of sufficient height to permit men to walk and work in comfortably.

Under proper restrictions this space could be rented to electric or other corporations to run their mains in, and a considerable income derived therefrom. Such companies could well afford to pay a good rental for the use of this space. In this way overhead wires could be dispensed with, together with their unsightly poles. There would be less necessity for digging up the streets and displacing the pavements, and there would be a great saving of time and expense in making repairs.

Let each city be very careful in granting permissions to use sidewalk vault space, and if it is not deemed wise to impose the restrictions suggested at present, let them make the term of free use short or terminable at short notice, so that when the matter becomes of sufficient consequence some such regulations may be adopted.

Thomas Appleton.

THOMAS APPLETON, born in Reading, Mass., in 1846, is a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the Boston Society of Civil Engineers, and the Western Society of Engineers. From 1862–4 he was rodman and assistant engineer on reconstruction of bridges and masonry, and location of branch lines of the Boston, Hartford and Erie Railroad. In 1864 he served one hundred days as a private in the Eighth Massachusetts Volunteers. In 1868, at Rensselaer Polytechnic Institute, he graduated as a civil engineer. From 1868 to 1880 he was practicing civil engineering in New England, was employed on location and construction of Dexter and Newport, Somerset, Sandy River, Maine Central, and Boston and Maine Railroads, in Maine; Vermont and Massachusetts, Troy and Greenfield, Fitchburg, Essex Branch, Lowell and Andover, and Marginal Freight Railroads in Massachusetts; New York and New England in Connecticut and New York, besides municipal public work in Boston, Mass., and Dover, N. H. In 1880 he was superintendent of bridges and buildings of the Galveston, Harrisburg and San Antonio Railroad in Texas. In 1881–3 he was chief engineer of the Leavenworth, Topeka and Southwestern, and Topeka, Salina and Western Railways in Kansas. In 1883–4 he was contractor for public work in Kansas, City, Mo.; in 1885–6 he was city engineer of East Saginaw, Mich.; in 1886-8 he was principal assistant engineer of the Chicago, Milwaukee and St. Paul Railway; in 1889–91 he was engineer of buildings of the Union Pacific System, and from 1891 to the present time he has been practicing civil engineering in Chicago and vicinity.

ORIGINAL METHODS IN PAVING AND SEWERAGE.

We have continued, in South Bend, to put down *single* course brick pavements on gravel foundation at a cost of from $1.00 to $1.15 per square yard, that give fully as good a surface and as general satisfaction as double course pavements that cost $1.54 per yard. This is not new to us, but possibly may be to some other cities.

We have continued to lay our brick at an angle of 45° with the street, instead of at right angles, as is usually done, and note that the city engineer of Memphis, Tenn., recommends the same angle. While this is not new with us, it would be considered new in many places, where, if tried, it would probably be recognized as an improvement, both in appearance and smoothness as well as in the wearing qualities of the pavement.

We continue to construct brick sewers up to 48 inches by 68 inches of a single ring (4 inches) that prove perfectly stable in our soil.

We also continue to discharge storm water into sewers through untrapped inlets.

We do not contend that all cities could adopt our methods in regard to sewers, but there are doubtless many that could do so with profit.

While acknowledging an inability to produce any new ideas or discoveries, we think the above will shield us from a charge of following old ruts, unless, indeed, the old ruts lead in the direction in which we wish to go. *Wm. M. Whitten.*

Wm. M. Whitten was born in St. Joseph county, Indiana, March 1, 1843. He was educated in the common schools of South Bend and the Northern Indiana College. He was a student at the latter at the beginning of the Civil War. He enlisted in Company I, Ninth Indiana Regiment, that company being the first one organized in the county. After being mustered out of the three months' term of service for which this company enlisted, he resumed his studies. In the spring of 1862 he again enlisted, this time as a private in the Twenty-first Indiana Battery, in which he served until mustered out at the close of the war as senior second lieutenant of the battery. While in the service he found considerable time to continue his studies in mathematics, not, however, with the expectation of putting the principles to practical use as a surveyor or engineer, but because it afforded more agreeable pastime than the usual pack of cards. After his return from the army his brother-in-law needed some surveying done, but was unable to get a surveyor to do it. He offered to do

the work, which proved satisfactory, and this led to his appointment to the office of county surveyor. Since that time he has served seven terms in that office. When the drainage act of 1881 took effect, he was surveyor of the county. Under that act he planned and superintended the construction of a large number of ditches, some of which were quite extensive. In May, 1872, he was appointed civil engineer of the city of South Bend, and, with the exception of one year, has held that office continuously since that time. In March, 1889, he was appointed engineer to the state board of commissioners appointed under the act of 1889 to secure the removal of the rock ledge in the Kankakee river at Momence, Ill. His work on this proposed improvement was highly commended by the president of the board, Prof. J. L. Campbell, of Wabash College, and formerly in charge of the geodetic survey in the state, also by Governor Hovey, to whom the commission reported. On January 26, last, he was elected president of the Indiana Engineering Society.

PUBLIC WORK IN TOPEKA.

THE financial pressure has caused a delay in the proposed improvements, so that but little has been done in Topeka this year. These are times to take careful observations and establish our reckonings. Topeka commenced making municipal improvements in 1887, and has spent the following sums: 1887, $489,381; 1888, $441,933; 1889, $150,825; 1890, $114,540; 1891, $152,995; 1892, $88,290; 1893, $24,707. Total, $1,462,671.

The larger portion of this has been spent for paving, and our future outlay is likely to be in about the same proportion for this purpose, so that the paving question is one of the most important in municipal economy. Our people were led to believe that asphalt paving was the very best, and in 1887 contracted with the Barber Asphalt Paving Company for 126,000 square yards, in 1888 for 57,515 square yards, in 1889 for 9,929 square yards, and in 1890 for 367 square yards, all at the uniform price of $2.80 per square yard, giving a bond for its maintenance for five years. The company have kept the asphalt repaired at considerable expense. Some portions subject to much wear have been resurfaced twice and other portions once during the five years. That laid on residence streets has required but little repair. The sixth year since it was laid has passed and the city will soon have to resurface large portions of the asphalt on our business streets. The best offer we have had for this work is from the Barber Asphalt Paving Company, who want $1.50 per square yard.

The paving was in the first place assessed to adjacent property, the city at large paying for the intersections. The property-owners

naturally object to being assessed a dollar and a half per square yard before their tenth and final payment of the first cost becomes due. The city at large has no fund to meet so large an expenditure without making a special assessment for this purpose, which, under our state laws, might prove illegal.

We have $542,000 invested in asphalt paving, which is likely to prove an expensive luxury. We can have the asphalt replaced with vitrified brick at a cost of ninety cents per square yard, which is being favorably considered. We have now 80,110 square yards of vitrified brick paving; some of it has been laid, subject to wear, since May, 1890. There has been but little repair work done on any of the brick paving. I think there has not been a single brick removed from any of this paving except it was taken out and replaced by the plumbers.

When we commenced the use of brick the business was somewhat experimental; it has improved until we have the best paving brick made. Our company took the first prize at the World's Fair, and our people appreciate the enterprise and prefer to encourage home industry. It is a fact that all pavements cost a considerable sum to maintain. We have 34,445 square yards of red cedar blocks on six inches of concrete, which has been laid five years, and not one dollar spent upon it until this fall, when I had some repairs made over sunken trenches, costing twelve dollars. We have 51,642 square yards of Colorado sandstone block paving which has been in place five years without any expense to the city. There is the question of smoothness, however, in favor of the asphalt. The wear and tear of vehicles is an expense, the difference in which should be credited to the asphalt, our smoothest pavement. The brick is next in smoothness, and cleanliness, not excepting the asphalt.

The city of Omaha, a few years ago, had a contract with the Barber Asphalt Paving Company for the maintenance of their asphalt paving, after the five year period had expired, at eight cents per square yard per year. The city engineer of Buffalo, N. Y., in his annual report for 1892, notes the expenditure of $37,573.17 for the maintenance of asphalt streets on which the five years maintenance period had expired. He wrote me that on January 1, 1893, they had 766,649 square yards. Allowing the expenditure to have

been made over it all, the cost would have been four and nine-tenths cents per square yard.

In August last I recommended to the mayor and council of this city to provide $5,000 for the repair of asphalt paving for the year 1894. This has not been done, and there is no money which can easily be spared from the general revenue or improvement funds, so that our asphalt paving is likely to prove a source of much annoyance in the near future.

On one of our principal streets, the one leading to the Atchison, Topeka and Santa Fe Railroad Depot, which is paved with asphalt, and on which our street railway had a track, the railway was enjoined by the court from taking up their track after having part of it removed. The street has remained in this unsightly, dangerous condition for more than a year, and yet the council nor the people are unable to move blind justice in the matter. To one on the outside it would seem that we were reckless or a little inclined that way. Public sentiment has done a great deal for Topeka, but it is too apt to fly off on tangents, and when it gets started there is not much left at the hub; in this we are but human.

Our brick pavement consists of two courses of brick on six inches of sand with an inch of sand between courses. At first I recommended concrete, but, owing to cost, was overruled. I have changed my views, and think sand is the best. All our streets are prepared for paving by thoroughly rolling with an Areling & Porter 13-ton roller. We have a yellow clay subsoil and the roller slides, and whenever it finds a depression works a hole on one side, then cants over and has to be helped out—sometimes jacked up and plank laid for it to run on. For our use the Lindelof roller is the best steam roller. The Barber Company had one here for two or three years and worked it by the side of our roller. Our English roller is all right on a good foundation, but we want a roller that will make a good foundation out of bad material. For a city of this size a reversible horse roller would be much better, cheaper and handier to use.

Our people believe in hard times. Seven years ago they spent a half million dollars for improvements. This year they spent only $25,000. The city has good credit, and has just sold $74,000 worth of five per cent. refunding bonds at par; yet the laborers who in

years past have had work must now seek it elsewhere. My own salary has been cut forty per cent. I, in turn, must reduce my expenses, and so we pass it round. Let everybody believe in hard times and we shall surely have all we want of it. A gentleman said to me yesterday, "I can reduce expenses by cutting down wages and discharging men, but I have a valuable plant, tools and fixtures, and am here to do business. The wages of a few men is a small item. Better use a good regulator and keep the machine running smoothly so far as it is possible to do so, and the final results will be better."

Engineers, of all people, are about the first to feel the financial depressions. I never knew them to strike or to be unreasonable as regards their compensation. As a class they are striving constantly to make the best of circumstances. *Lewis Kingman.*

LEWIS KINGMAN was born in Brockton, Mass., February 26th, 1845. He graduated at Hunt's Academy in 1861. He commenced engineering with J. Herbert Shedd, now city engineer of Providence, R. I., on the 15th of September, 1862, at Boston, and was for two years employed on all kinds of city and suburban work. In 1864 he went to Wilkesbarre, Pa., in the employ of Martin Coryell, M. Am. Soc. C. E., developing mines, making borings for coal, and on railroad location. In January, 1865, he worked in New York city for Hamilton E. Towle, and in March went with him to the oil regions of Pennsylvania, where he was employed about one year. He then operated in oil and wells until March, 1868. He then went to St. Louis, Mo., where he was employed by Mr. Cozzens for three months, and in July of that year commenced work under Thos. McKissock, chief engineer of the Atlantic and Pacific Railroad. In Missouri he continued with this company until October, 1871, serving the last year under Jacob Blickensderfer, chief engineer. In 1871 and 1872 he located a railroad line from Kit Carson, Col., to Cimarron, New Mexico, a distance, of 163 miles, which was not built. During the years 1873–4–5 he was employed by the United States surveyor-general of New Mexico, and surveyed 2,500 miles of township and section line. He did considerable work on irrigating canals, ditches, dams and pipe lines, and invested some capital in the stock and sheep business, and lost some in merchandising. In July, 1877, he was employed by A. A. Robinson, chief engineer of the Atchison, Topeka and Santa Fe Railroad, on surveys in Colorado and New Mexico; in 1878 and 1879 was locating engineer for the Santa Fe, and was sent to the Atlantic and Pacific in September, 1879, and located most of that road from Albuquerque to the Colorado river. He was appointed chief engineer of the Atlantic and Pacific Railroad January 1, 1882. While in charge he built the Canon Diable bridge and laid the track from there to Seal Springs—204 miles—constructing the many bridges, one tunnel, and grading the roadway over a very rough mountainous region. Owing to the scarcity of water he had to haul water 180 miles for the use of engines, teams and men a portion of the time while laying track. At Winslow, Arizona, he sank a well 1,800 feet, and at Ash Fork 900 feet without getting water. April 1, 1883, he was appointed chief engineer of the Mexican Central Railway (northern end) by Thos. Nickerson, president, and D. B. Robinson, general manager. From the 1st of April, 1883, to the 1st of July, 1884, he built 452 miles of the Central Company's line from La

Cruz to Calera, with stations, division yards, round-houses, wells, and appurtenances complete. After completing the Central he returned to the Santa Fe in July, 1884, and served as assistant to A. A. Robinson, chief engineer, until January 1st, 1889. In 1886 he constructed and laid track on 508 miles, in 1887 on 845.6 miles, and in 1888 on 40 miles, with depots, round-houses and bridges complete for operating on lines in Kansas, Indian Territory and Texas. April 16, 1889, he was appointed city engineer of Topeka, Kan. He served under Mayor R. L. Cofran for four years, and was appointed April 10, 1893, by Mayor D. C. Jones for another term of two years. He owns a suburban home and 200 acres of land a few miles north of Topeka.

A PROMISE OF CHEAPER CEMENT.

One of the most interesting matters which has come to my notice lately is an invention made by some European manufacturers, and exhibited, I think, in the Swedish building at the World's Fair, regarding the use of cement. The idea, which to me was new, consisted in grinding pure sand into a powder and mixing it with the cement, and thus obtaining what is called "Sand Cement." If the sand is ground as fine as the cement it does not deteriorate its setting properties materially, but enables the same amount of cement to go much further, and therefore furnishes cheaper mortar at a certain strength than we have been able to get heretofore.

If everything turns out as promised, and I see no reason to doubt it, this will decrease the cost of first-class masonry laid in hydraulic cement, and it will also, I think, stimulate the manufacture of the best artificial cement, which seems to be the only one which can be profitably used for making sand cement.

Rudolph Hering.

A NEW FEATURE OF METAL CURB CONSTRUCTION.

We have introduced on the High street viaduct now being constructed here under my charge, a detail of all metal curb construction, which I believe is a new departure in this particular line. The curb itself is composed of two angle-irons placed back to back in such a way that rivets in the outside rivet line of the flanges of the girders will catch them, thus enabling us to have the girders with their curbs finished at the shops, and no further work is necessary to be done on them after their erection in place. It is apparently a small matter, but its success has highly pleased me.

Josiah Kinnear,
Chief Engineer City of Columbus.

THE MANUFACTURE AND USE OF PAVING BRICK.

[Abstract from a paper read before the International Engineering Congress at the World's Columbian Exposition.]

The generic term brick includes within its meaning classes of material of such wide variations in their particular qualities as to need a more definite classification when considering the adaptability of such classes to particular purposes. So, when we consider a certain class of this material for street paving it must not be confused with other classes manufactured for other purposes, and perhaps entirely unfit for this particular use. These manifold qualities of brick are due partially to methods of manufacture, but more largely to greatly diversified qualities of the clay from which the brick are made.

OCCURRENCE AND DISTRIBUTION OF CLAYS.

Clays may be classed as to their origin and occurrence as follows: (1) Residuary clays result from the disintegration of rocks in place. The soluble and binding materials are leached out and washed away and leave the insoluble materials in a more or less divided form as clay. This takes its character of the rock from which it is derived, modified by the action of water. Some of the purest clays are derived in this way from feldspathic rocks from which the alkalies have been leached, leaving a clay closely resembling kaolin (pure clay). Other less pure clays are derived from the disintegration of limestone, sandstone, etc.; in each case, however, the soluble constituents are almost entirely gone, leaving the insoluble silicates, quartz grains, alumina and ferric oxide. Clays Nos. 1, 2 and 3 in Table I. are examples of this class of clays. (2) Drift clays are the result of the mechanical action of the ice during the glacial period, by which the various formations were ground up and mechanically transported and redeposited largely without the aid of water. These clays represent the character of the mother rock much more accurately than those of class one, as in this case the soluble matter is largely retained and not leached out, except by the action of the water, since their deposition. (3) Alluvial clays are residuary, and drift clays rewrought and redeposited by fluvial agencies. (4) Indurated clays, or argilaceous rocks and

shales, are formations resulting from the disintegration of the earlier rocks by various influences and their reformation into new strata. They have usually been subjected to great pressure from the superincumbent rocks, to which pressure they owe their physical character to a large extent.

Of these four classes, the residuary clays (class one) are found wherever rocks and the result of their disintegration have been undisturbed by fluvial or drift influences, and are hence found largely outside the drift areas. The clays of class two are found within the drift sheet, and constitute the common brick clays of the Northern States. Those of class three occur along the various river courses; while those of class four occur in the many geological horizons, which we may briefly summarize as follows, beginning with the oldest and lowest geological horizon: (a) In Utica, slate as a dark carbonaceous clay slate; hard in Pennsylvania; soft in New York, sometimes imbedded with impure limestone. (b) In the Hudson river shale as shales, and shales more or less interbedded with limestone (over five thousand feet thick in Pennsylvania and two hundred feet thick in Illinois). (c) In the Salina (or Onondaga salt group) as a red shale (in New York state, from one to five hundred feet thick). (d) In the Devonian as the Marcelius shales, a black slate, somewhat bituminous. As the Hamilton group, consisting of slates, shales and sandstones, three hundred to seven hundred feet thick; as the Genesee formation, the black slate of the west and south; as the Portage group, consisting of shales and flagstones; as the Chemung group, consisting of thin bedded shales, sandstones and flagstone. (e) In the Carboniferous in which are developed the most extensive beds of fire-clays, potters' clays, shales, soapstone, etc., interbedded with sandstone, limestone and coal. (f) In the Triassic, which usually consists of dark sandstones, soft shales and coarse conglomerate. (g) In the Cretaceous and Tertiary, which consists of earthy formations of sand and clays.

Of the deposits of clay above named, the clays from the carboniferous period are most widely utilized for the manufacture of paving brick. At Columbus, Ohio, the Devonian shales, or the product of their disintegration, is utilized, while at Syracuse the Salina shale is found available. Some few drift clays are also successfully used for the manufacture of a fair quality of paving brick, notably

at Decatur, Jacksonville and Urbana, in Illinois. A mixture of drift clay and carboniferous clay is utilized at Brazil, Ind., for the manufacture of paving brick. The accompanying map shows the distribution of the carboniferous deposits east of the Rocky mountains and also the outline of the drift area. It also shows the location of the principal paving brick factories and the principal cities which are now using this material for paving within the territory shown.

CHARACTER OF CLAYS.

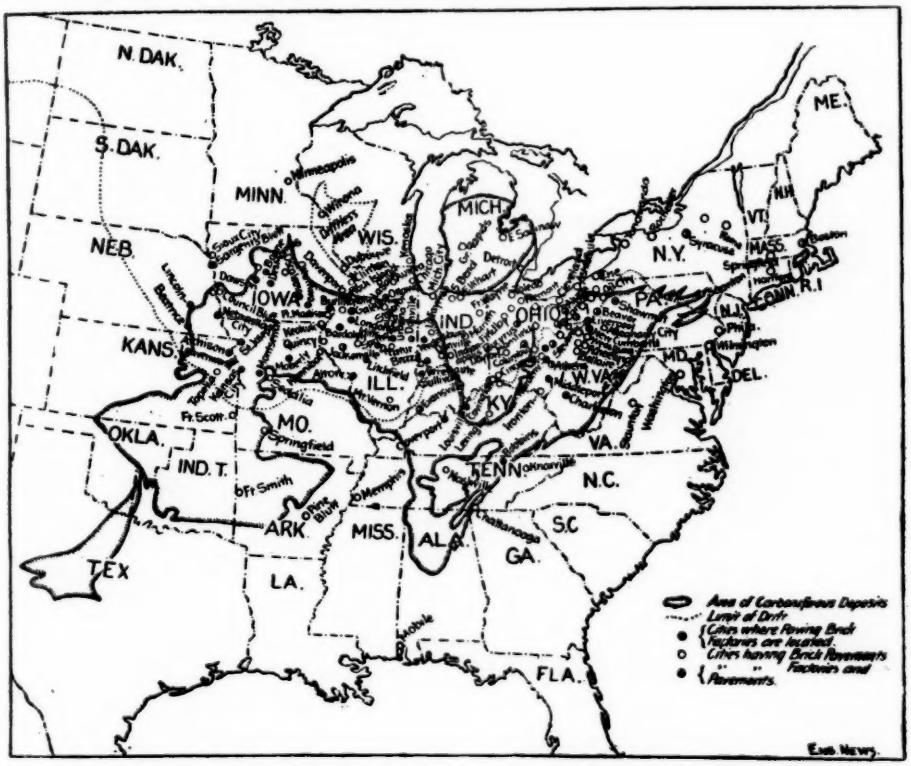
As may be judged from its wide occurrence and manifold compositions, clay varies widely in its extreme characters; but all materials to be classed as clays must have certain constituents in common. The essential ingredient is a hydrous silicate of alumina, known as kaolin, which, according to Prof. G. H. Cook, is composed of:

Silica	46.3
Alumina	39.8
Water	13.9
	100.00

This may be considered a pure clay, and is rarely, if ever, found in nature. To this is commonly added in varying quantities, silica, lime, magnesia, ferric oxide, potash and soda. The presence of these substances, which may be regarded as the impurities of clay, and the physical condition under which they exist, cause the wide variation in the clays themselves and to a great extent in the manufactured product made therefrom.

CHARACTER DUE TO CHEMICAL CONSTITUTION.

Pure alumina will resist the highest temperature of the blast furnace, in which crystalline (quartz silica) will be only slightly affected, both being practically infusible. Alumina shrinks, warps and cracks greatly in drying but gives plasticity and adhesiveness to the clay and strength to the product. Silica prevents cracking and distorting, the more silica being present the less the shrinkage. But the more silica the less plasticity and adhesiveness of the clay and the less strength and greater brittleness. Lime and magnesia, while infusible in themselves or with alumina, fuse in the presence of an excess of silica, as do also several other common ingredients of clay, and form a "vitrified brick."



MAP SHOWING LOCATION OF PAVING BRICK CLAY DEPOSITS AND CITIES MANUFACTURING AND USING BRICK PAVING.

It is found that potash has the most active fluxing effect on clay, after which follow soda, lime, magnesia and iron, in the order named. To "vitrify," a clay should contain at least three per cent. potash, or three and one-half per cent. of soda, or five per cent. of lime of magnesia, or eight per cent. iron, or a combined proportion of any or all of these fluxes equal to these amounts. An appreciable less amount of these fluxing elements will leave the product more of the nature of a fire-brick, unvitrified and porous, and, as a rule, unfit for paving purposes. A greater proportion than above specified is desirable, and will make the clay more easily vitrified at a less heat, and is to some extent a measure of its economic manufacture, as a lower heat and consequently less fuel will be required in its burning. Too great an amount of these fluxes, amounting, perhaps, to three times the quantities above mentioned, will render

the clay hard to handle on account of great fusibility. According to Richter, lime and magnesia are more active fluxing agents than potash and soda, but his conclusions do not agree with American experience. The presence of lime or magnesia in a paving brick in reasonable quantities is not believed by the writer to be detrimental to the brick if it exists in a finely divided state and is intimately commingled with the other constituents, so that a silicate of lime or magnesia will be formed in the burning. The Milwaukee building brick is one of the best of common brick, and it contains a large percentage of lime, and Portland cement contains often as high as sixty per cent. of lime. In each case, however, the lime exists in close chemical or physical union with the other elements of the material.

Iron in considerable quantities has a fluxing effect with silica, and to this extent cements it together and gives it strength. It is not the most valuable of constituents in this regard, however, and its presence is not essential to a first-class paving brick. Iron, when present, is usually in the form of hydrous peroxide or protoxide of a yellowish or bluish color. During the burning, the water of crystallization is expelled and the iron takes the form of the red peroxide, giving its color to the material in proportion to the amount present. Potash and soda fuse at a lower temperature than the other constituents of clay, and their presence in suitable quantities is desirable for the manufacture of vitrified paving brick.

In Table I the analysis of various paving brick clays are given with that of some other noted clays for comparison. These analysis have been compiled from a variety of sources too numerous to be mentioned in detail.

CHARACTER DUE TO PHYSICAL CONDITION.

The influence of physical condition is equally important to that of chemical character. Many of the clays from the older formations have compressed and consolidated and form slates and other hard argillaceous rocks; others less compact form the shales, while others exist in a plastic form. There is a marked difference in their adaptability for manufacturing use under these varying conditions, and the methods of manufacture must be largely determined by them. If a clay is not found naturally in a plastic condition, it must be

reduced to a finely divided state by mechanical means before it can be tempered and made into paving brick. While as previously noted, the fusing of clay depends on its constituents to a great extent, yet its physical condition also modifies this quality largely. Coarse clay, even with considerable of the fluxing materials, will resist considerable heat. The more finely clay is ground the more easily it is vitrified and the tougher, stronger and more impervious its produce becomes. Fineness in grain is an essential feature of the best paving clays.

The ingredients of the clay exist in various forms which affect the clay and its product. The uncombined silica may be more or less finely divided and its condition has its effects on the action of the fluxes. In clays derived from feldspathic or micaceous rocks, undecomposed feldspars and micas sometimes occur. Lime, instead of being finely divided, may occur as lumps or peddles, in which condition it will unite with the other ingredients only on its surface, the balance burning into caustic lime, which, on exposure, will gather moisture and slack, disintegrating and crumbling the brick. In general, a clay which will fuse and vitrify, but keep its shape, is essential to the manufacture of the best paving brick. Analysis and physical examination will point out the probability of the development of certain characteristics in the manufactured product, but, after all is done, the only thorough test is the working of the clay by suitable methods and its proper burning.

THE MANUFACTURE OF BRICK.

The greatest diversity, both in the mechanical and chemical constitution of clays, renders the question of method of manufacture a difficult one, for the knowledge of the successful utilization of one clay is not wholly applicable to another. All clays are improved by being loosely thrown up and exposed to the weather, and some clays are improved by thoroughly wetting and allowing them to lie for a day or more. The nearer homogeneous and fine grained a clay naturally occurs, the fewer processes necessary in handling it.

The soft mud process is used only to a very limited extent in the manufacture of paving brick, Bloomington, Ill., being the only place familiar to the writer where this process is still used. The dry press process of brick manufacture has not as yet come widely into

use for the manufacture of paving brick, although certain clays might be worked by this method, and the writer understands that some paving brick are being made at Middleport, Ohio, and Louisville, Ky., by this method, although he has not seen them. What is known as the stiff mud process is the one usually adopted for the manufacture of paving brick, and seems to be the best adapted for the present circumstances of its manufacture.

The clay, if indurated, is first reduced to a powder, usually by means of the granulator or dry pan, and then thoroughly tempered in a suitable pug mill before passing to the brick machine. As a rule, the longer and more thoroughly the clay is worked or tempered, the more uniform and better will be the resulting product. The auger machine has given the best satisfaction in the manufacture of stiff mud brick, and the machine-makers of the United States have adopted this type of machine almost universally. On leaving the machine, the brick manufactured by this process are dry enough to handle, and they are placed on trucks or cars and conveyed at once to the dry-house. Some makers re-press their brick before drying, but it is not common practice at present, although many factories furnish both common and re-pressed paving brick.

DRYING.

Several systems of drying are in successful use among the paving brick manufacturers: (1) By a hot floor, which may be produced by furnaces or steam pipes under the floor over which the brick are hacked to dry. (2) By slatted floors under which are steam piping and over which the brick are hacked to dry. Sometimes a modification of this method is used in which the dry house has racks from floor to ceiling on which the brick are placed for drying. (3) A system of flues or tunnels into which the brick are run on cars, which will hold about 500 brick each. These tunnels are heated by means of furnaces or steam pipes. The third method in one of its various forms seems best adapted for handling large quantities of brick, as the brick can usually be dried in from 18 to 36 hours by this method, where it takes from one to five days on the dry floor and from five to ten days if dried in racks. The saving in time and cost of handling is also considerable. Outdoor drying is a method too slow and uncertain for practical use in handling

TABLE I.—Showing Analyses of Paving Brick Clay From Various Localities.

	Silica.	Alumina.	Perox. of iron.	Protox. of iron.	Lime.	Magnesia.	Potash.	Soda.	Water and loss.	Undetermined.	Total.	Geological source of clay.
Kaolin	46.30	39.80	.....	.....	.....	.....	.....	.....	13.90	.....	100.00	Pure clay.
Stonebridge, Eng	67.34	23.03	.....	2.03	.....	.....	1.38	1.38	8.24	.....	102.02	Fire clay.
Mt. Savage, Md., non plastic.	50.46	35.90	.....	1.50	0.13	0.02	*Nil*	*Nil*	12.74	Mang. oxide trace.	100.75	Fire clay.
Milwaukee (white brick)	38.22	9.75	2.84	1.16	3.24	15.83	2.16	0.65	2.80	Carb. of lime, 23.20	99.85	Drift clay.
Phillipsburg, N. J.	56.78	17.38	6.50	Phosphorus. 0.133	4.14	3.15	and organic matter. 3.427.		and carbonic acid. 7.600	Sulphur, 0.89	99.910	
Syracuse, N. Y.	67.67	11.67	6.53	.....	12.74	0.95	0.80	0.80	.....	.....	100.36	Salina shale.
Cumberland, W. Va.	69.02	22.07	4.53	.....	1.70	0.38	1.34	1.34	.....	0.96	100.00	Carboniferous.
New Brighton, Pa.	67.36	22.05	5.61	.....	0.86	0.36	2.70	2.70	.....	1.06	100.00	"
Canton, O.	67.65	18.36	8.34	.....	0.80	1.02	2.58	2.58	.....	1.25	100.00	"
New Lisbon, O.	64.08	25.32	5.44	.....	0.30	0.29	0.63	0.63	.....	3.94	100.00	"
Middleport, O.	71.57	17.06	8.34	.....	0.50	0.58	0.56	0.56	.....	1.39	100.00	"
Brazil, Ind.	77.67	14.77	3.63	.....	0.38	0.27	2.43	2.43	.....	0.85	100.00	" and drift clay.
Columbus, O.	66.30	18.62	9.78	.....	0.40	0.84	1.89	1.89	.....	2.17	100.00	Devonian shale.
Akron, O.	60.05	20.00	6.82	.....	0.52	0.45	1.79	1.60	1.95	Sulphur, 1.95	101.11	Carboniferous.
Haydensville, O.	72.24	16.87	Iron 0.16	.. ..	0.50	trace	1.09	1.09	5.14	.....	100.00	"
Zanesville, O.	61.80	20.76	8.70	.....	1.38	1.09	1.44	1.44	.....	4.83	100.00	"
Robbins, Tenn.	70.57	15.19	7.97	.....	0.78	0.32	1.15	1.15	.....	4.02	100.00	
Rock Island, Ill.	60.64	22.84	6.10	.....	0.24	0.75	3.28	0.57	5.00	.....	99.42	Carboniferous.
Galesburg, Ill.	68.69	17.95	7.25	.....	0.76	1.47	2.83	2.83	.....	1.05	100.00	"
Ottawa, Ill.	52.96	33.47	.....	4.51	3.01	2.91	1.10	1.10	2.74	.....	100.00	"
Clinton, Ia.	75.50	13.04	Iron 4.00	.....	0.50	.....	4.50	.....	3.00	.....	100.90	Hudson river shale.
Burlington, Ia.	77.40	11.74	3.29	.....	1.60	1.91	3.76	0.47	.....	.....	100.17	Carboniferous.
Bloomington, Ill.	67.80	11.55	4.31	.....	8.90	5.32	2.62	2.62	.....	.....	100.00	Drift clay.
Ft. Smith, Ark.	57.10	23.74	8.18	.....	0.53	1.04	1.53	0.87	7.31	.....	.....	Carboniferous.
Kansas City, Mo.	64.37	19.73	9.07	.....	0.82	2.32	1.89	1.89	.....	1.80	100.00	"
Leavenworth, Kan.	58.45	21.96	Iron 8.43	.....	1.05	1.57	2.00	2.00	6.51	.....	99.94	"

large quantities of brick. Clays vary greatly in the facilities with which they may be dried. Clays highly aluminous must be dried with great care and often very slowly, otherwise they warp and crack, while those with much silica will stand forced drying. Thorough drying greatly facilitates the burning of the brick.

BURNING.

There are two methods used for burning brick. The ordinary way in which common building brick are burned is in the up-draft or clamp kiln. This furnishes good ordinary brick, but it is almost impossible to get a uniform product, not over 40 per cent. of the brick in a kiln being available for "pavers." The down draft kiln secures a uniform and much higher temperature, a large percentage of the brick, from 80 to 90 per cent. in a well designed and well constructed kiln, being suitable for paving purposes.

In burning brick, the fire must be started slowly in order to "water smoke" the brick without cracking them. In the brick, as they come from the machine, there is from 20 to 30 per cent. of water; about 50 per cent. of this water is the water of the pores, and is removed at a temperature of 212° F. in the drying. The balance is lost at a temperature of about 1,400° F. in the burning. The loss of the physical and chemical water of the brick is accompanied by a corresponding loss in weight, and a considerable shrinkage in the dimensions of the brick, as may be seen from the following table:

	On leaving machine.	On leaving dryer.	Burned not vitrified.	Vitrified.
Weight	6.46 lbs	5.79 lbs	5.08 lbs	5.08 lbs
Length	8½ ins	8 ins	7⅞ ins	7¾ ins
Breadth	4 7-16 ins	4 3 16 ins	3⅞ ins	3¾ ins
Thickness	2½ ins	2¼ ins	2⅛ ins	2 ins

Average of 12 samples.

Slow firing is continued until the smoke passing off shows no further signs of the water smoke (steam), after which the fires are gradually raised until the temperature throughout the kiln is sufficient to vitrify the brick, at which point it is held until they reach the proper point of vitrification, which is shown by the trial pieces or whole brick taken out through inspection holes in the top and sides of the kiln. After this the kiln is gradually cooled down and the brick removed. Too rapid cooling is detrimental, as the brick are rendered very brittle. By slow cooling the brick are annealed

and rendered tough. The burning occupies from two to four days for water-smoking, from four to six for burning proper, and from three to five days for cooling.

TABLE II.—SHOWING METHOD OF MANUFACTURING PAVING BRICKS NOW IN PRACTICE.

Locality.	Kind of Clay.	Geologic'l Origin.	Methods of Manufacture.	Method of Drying.	Character of Kilns.
Brazil, Ind.....	Fire clay and surface clay mixed.	Carbonif. and drift.	Dry pan. Pug mill. Stiff mud mach.	On slat floor.	Down draft.
Decatur, Ill.....	Surface clay.	Drift.	Roller crusher. Stiff mud machine.	On rack in steam heated dry house.	Down draft.
Bloomington, Ill.	Surface clay.	Drift.	Vertical pug mill. Soft mud mach.	In yard.	Up draft.
Galesburg, Ill....	Shale clay.	Carbonif.	Dry pan. Pug mill. Stiff mud mach.	On cars in drying tunnels.	Square. down draft.
Galesburg, Ill....	Shale clay.	Carbonif.	Dry pan. Pug mill. Stiff mud mach.	On hot floor heated by furnaces below.	Round and square down draft.
Evansville, Ind..	Shale clay.	Carbonif.	Dry pan. Mixer. Pug mill. Stiff mud mach.	Tunnel dryer.	Square down draft.
Rock Island, Ill..	Shale clay.	Carbonif.	Dry pan. Screen. Pug mill. Stiff mud mach.	Tunnel dryer.	Round down draft.

Table II gives some details of the methods of manufacture as used at different paving brick factories in the United States.

QUALITIES OF PAVING BRICK.

In all lines of practical work, experience with a given material is the only satisfactory method of determining the value of its various qualities. As in the case of cement, stone and wood, paving brick must be selected with due reference to the uses to which they are to be put; that is to say, to the nature and extent of the traffic they are to encounter and the character of the climate they are to withstand. A large percentage of clays are undoubtedly capable of producing brick suitable for country roads, light suburban travel and residence streets of towns and cities. From many can be made brick which will withstand the moderate traffic of the smaller cities of from 30,000 to 50,000 inhabitants. It is the writer's belief that clays can be found which, if properly manufactured and properly placed in the pavement, will outrival granite under the heaviest traffic, and some brick are now made which it is believed would prove economical under such traffic.

The color in a brick is no criterion of its value as a paving

brick when comparing brick of various makes; but, in inspecting brick from a single factory, the color will usually furnish a fairly safe guide as to the relative hardness, when the inspector is thoroughly acquainted with the particular manufacture. Another criterion as to the character of any single make of brick is the comparative size. As the harder a brick is burned the smaller it becomes up to a certain limit, which must be determined for each make of brick, the unduly large brick may be unhesitatingly rejected as too soft. In general, a brick for paving purposes may be homogeneous, free from uncrushed or lumpy material, especially if such material is not united by vitrifaction with the balance of the material of the brick. Vitrifaction is desirable, but not essential, as many paving brick, especially those made in West Virginia, can not be classed under this head. These are made from clays very near fire-clays in character, and are giving very good satisfaction, at least under moderate traffic.

In this country the climate in which the majority of paving brick is used is so severe that the disintegrating effects of frost are the most severe test a paving brick must stand, especially in streets of moderate traffic. Hence, one of the first requisites of such a brick must be that it will not absorb a large percentage of water. The permissible ratio of absorption can not be definitely fixed at any given percentage, for it is found that this ratio varies with different classes of brick. One class of brick, which seems to be uniformly made from clays which approach near to fire clays in character, will admit four or five per cent. of water and still not crumble through the action of frost; while others, if not burned hard enough to render them impervious to more than two and a half to three per cent., will be rapidly disintegrated by the frost. A core or lamination affords a seam where the frost may enter, and is inadmissible in paving brick. Fire cracks should be limited in number and extent. The presence of lime in itself is not detrimental in limited quantities, yet this must not exist as lime pebbles, or it will render the product entirely unfit for use by disintegrating and crumbling it.

The specific gravity of a brick is somewhat of an index of its comparative value, as the more material contained in it the greater its density, and other things being equal, the greater its resistance to abrasion, crushing, etc. A certain amount of toughness is de-

sirable in a paving brick, to prevent splintering and breaking under traffic. This quality, the writer believes, is at present overestimated, as when laid in the street a brick can splinter only to a limited extent at the corners, after which the shape assumed is such as to greatly resist abrasion. The brick must be of sufficient transverse and crushing strength to resist all the demands of traffic with a sufficient factor of safety. Further than this these qualities are of little material value.

TESTING THE MATERIAL.

In making tests for relative qualities of brick, nothing will take the place of experience. A few general suggestions, however, for making ready tests, such as are now in use, are offered with the hope that they may prove serviceable. The test for crushing strength is believed by the writer to be of little or no value unless in comparison of the value of high-grade paving brick. The test is difficult of application, requiring expensive machinery, and unless carefully made by skillful observers, under definite given conditions, the results are very uncertain and unreliable. The transverse strength can be determined with greater accuracy than the crushing strength; it also represents both the compressive and tensile strength of the material, and is, therefore, a better test of the qualities of the brick. In testing for ratio of absorption the brick should be placed in a drying oven and kept at a temperature of about 212° F. for ten hours or more if they have previously been saturated. They should then be weighed, and after the weight is carefully determined, placed in a vessel of water and kept for 24 hours at a temperature of about 60° F., after which they should be taken out, the surface water carefully removed and again carefully weighed. The gain in weight, divided by the original weight, will give the ratio of absorption. The presence of caustic lime is easily told by immersing the brick from one to four days in water. If caustic lime be present it will make its appearance by breaking or cracking the brick or by "poppers" showing on the surface. The specific gravity can be readily determined. The test for toughness or abrasive strength is usually made in an ordinary foundry tumbler. The brick should be tested a few at a time, with about 100 pounds of "foundry shot," weighing not more than ¼ pound to

the piece. Heavy pieces of iron should not be used in this test, as they break the brick to pieces instead of wearing it. The different shapes of brick are apt to make a material difference in their wear during the first half hour. This is caused by some brick being manufactured with rounded edges and some with square edges; the latter, being more easily broken or abraded, cause a greater loss in the material so made. For this reason they should be weighed after the first half hour, and the results of the second or third half hour used for comparison.

SPECIFICATIONS.

The large majority of specifications for paving brick are entirely inadequate. They are vague and often meaningless. It should be remembered that each additional requirement cuts out certain classes of brick, lessens the competition, and in that way, and by reason of the extra cost in the manufacture of a higher grade article, increases the price of the finished pavement. It must also be observed that with the present demand for paving brick and the state of the manufacture in many places where factories have been recently established, it will often be impossible to obtain brick which will fall within the higher limit herein named. Hence, the engineer should assure himself of the best quality of brick which can be obtained in sufficient quantities for his use, before adopting specifications calling for any particular grades of paving brick.

THE PAVEMENT.

The use of brick for paving in the United States has been confined to the last two decades. Its first use was at Charlestown, W. Va., and at Bloomington, Ill., about twenty years ago. From these points, with their small beginnings, its use has spread until at present it is one of the most popular and widely used of all paving material. A discussion of the principles that underlie brick paving would be a discussion of the principles of all paving. This material simply offers a surface covering, smooth and even, but not slippery, durable, economical and highly sanitary. It must be laid on a foundation drained and prepared as for all pavements. Beyond this the success of the pavement depends on the proper selection of the material. With poor material it will prove a failure, as has been shown by the attempt to utilize common building brick

at Nashville, Tenn., and elsewhere. With proper material it is an established success, and is destined, with the improvement in manufacture and the bettering and cheapening of the product thereby, to rank first in economy and availability of all paving material. In the majority of places it offers a possible local industry, when the availability of the local geological resources are better known and appreciated and the different methods of utilizing them in manufacturing are more thoroughly understood.

In first cost the pavement depends on the nearness of the manufactories and the local resources suitable for foundations. For light traffic the fragmentary materials (rubble, gravel, sand, etc.), or sand with a layer of brick laid on their side, or six inches of concrete, make good foundations, the selection depending on the local resources. For medium traffic, nine inches of stone or gravel, or six inches of gravel or stone, with a layer of brick laid on their sides, bedded in sand, or six inches of concrete, will give good results. For heavy traffic the stone or gravel should be at least one foot in thickness, or the concrete at least nine inches. All sub-foundations which are retentive of water should be properly and thoroughly drained.

In the average city the network of pipes and conduits laid below the street surface is the cause of frequent disturbances of the pavement which is often the leading factor in its destruction. The facility with which pavements can be taken up and replaced becomes, under such circumstances, quite important. In this, brick pavement is second to none. The brick, being uniform in size and shape, can be returned to their places by unskilled labor, an important point in smaller towns and cities. This is especially true if the fragmentary foundations are used, and if sand only is used in the joints. Where either coal tar or cement grout is used in the joints, the brick taken up are difficult and often impossible to clean, and new material has to be substituted. With sand in the joints the old material is readily cleaned, and the sand, in two weeks' time after laying, renders the pavement as impervious to the seepage of surface waters as the tar or cement.

The durability of brick pavements is a subject open to inquiry, for the limited time they have been in extensive use has been too short to answer this from practical experience. The destruction of

TABLE III.—SHOWING CHARACTER OF BRICK PAVEMENT IN 42 CITIES OF THE UNITED STATES.

EASTERN AND SOUTHERN STATES.

City.	Years in use.	Foundation.	Depth of sand cushion, ins.	Size of brick ins.	Filling of joints.	Average cost per sq. yd.
Hartford, Conn.	½	Sand	...	3x4x9	Tar	$2.75
Wilmington, Del.	2½	Broken stone and sand	...	2½x4½x8¼	Sand, tar or grout	2.00
Scranton, Pa.	5	Gravel, sand or 4 ins. concrete	...	2½x4x8	Tar and sand	2.10
Cincinnati, O.	3	6 ins. concrete	...	3x4x9	Coal tar	2.50
Columbus, O.	7	Broken stone or concrete	...	2x4x8 to 3x4½x9	Tar or grout	1.50 to 2.25
Dayton, O.	...	6 ins. concrete	2	2¼x3¾x7⅞	Tar or grout	.....
Findlay, O.	3	8 ins. broken stone, 4 ins. gravel or sand	...	2½x4½x8½	Coal tar	.....
Massillon, O.	3	6 ins. sand	2	.....	Sand and tar	.....
Evansville, Ind.	3	6 ins. concrete	...	2½x4½x8½	Sand	1.70
Ft. Wayne, Ind.	1	6 ins. broken stone	2	2½x4x8½	Sand	1.55
Indianapolis, Ind.	2	6 ins. concrete	...	2¼x4¼x8¼	Tar and grout	2.40
Lafayette, Ind.	3	8 ins. gravel, 2 ins. sand, course brick flatwise	1	.....	Sand	.....
Terre Haute, Ind.	1	8 ins. broken stone	2	2½x4¼x8½	Grout	2.25
Detroit, Mich.	3	.....	...	2¼x4x8½	Coal tar	2.00
Charleston, W. Va.	22	3½ ins. sand and tarred boards	1½	2x4x8	Sand	1.15
Wheeling, W. Va.	10	8 ins. gravel	2	2x4x8¼	Coal tar	1.35
Mobile, Ala.	5	Sand and course brick flatwise	1	2½x4x8	Sand	1.50
Memphis, Tenn.	4	6 to 9 ins. concrete	...	2½x4x8¾	Asphalt	2.78
Louisville, Ky.	1½	6 ins. concrete	...	2½x4½x8½	Coal tar	1.65

WESTERN STATES.

Alton, Ill.	2	6 ins. broken stone, course brick flat	1	2¼x3¾x7⅞	.....	2.16
Bloomington, Ill.	18	2 ins. cinders, 2 ins. sand, course brick flat	1	2¼x3¾x7⅞	.....	1.40
Galesburg, Ill.	6	6 ins. sand, course brick flat	1	2x3¾x7¾	Sand	.....
Jacksonville, Ill.	4	6 ins. cinders, 1 in. sand, course brick flat	...	.....	.....	.....
Ottawa, Ill.	2	6 ins. sand, course brick flat	...	.....	.....	.....
Peoria, Ill.	6	6 to 8 ins. gravel or 6 ins. concrete	1	4x5x12	Sand	1.74
Quincy, Ill.	6	8 ins. broken stone, 2 ins. sand, course of brick flat	1	2½x3¾x7¾	Sand	.....
Rockford, Ill.	1½	6 ins. broken stone, 2 ins. sand. 6 inches broken stone, 2 ins. sand, course brick flat	1	2½x3¾x7¾	Sand	1.34 to 1.74
Rock Island, Ill.	4	6 ins. broken stone, 2 ins. sand. 6 inches broken stone, 2 ins. sand, course brick flat	1	2½x3¾x7¾	Sand	1.65 to 1.40
Springfield, Ill.	6	6 ins. cinders	...	2x4x8	Sand	1.50
Kenosha, Wis.	½	6 ins. concrete or broken stone	1	2¼x3¾x7¾	Sand	.....
Burlington, Ia.	5	6 ins. broken stone, cinders or sand, with course of brick flat	1	2¼x4½x8½	Sand	1.65
Clinton, Ia.	4	6 ins. broken stone, with sand	...	2½x3¾x7⅞	Sand	1.35
Cedar Rapids, Ia.	...	2¼ ins. sand, course brick flat	1	2¼x3¾x7⅞	.....	.....
Council Bluffs.	4	4 ins. sand	...	2¼x4x8	Sand	1.32
Davenport, Ia.	5	8 ins. broken stone, with sand, 6 ins. broken stone, course brick flat	...	2¼x3¾x7⅞	Sand	1.38 / 1.70
Des Moines, Ia.	...	4 ins. sand, course brick flat	1	2¼x3¾x7⅞	Sand	.....
Dubuque, Ia.	½	6 ins. concrete	...	2¼x3¾x7⅞	Sand	1.69
Keokuk, Ia.	½	5 ins. broken stone, 3 ins. sand, course brick flat	1	2¼x4x8	Sand	1.68
Omaha, Neb.	5	6 ins. concrete	2	2¼x4x8	Sand	1.95
Hannibal, Mo.	2	4 ins. broken stone, 3 ins. sand, course brick flat	1	2x3¾x7¾	Sand	.....
Atchison, Kan.	5½	4 ins. sand, course brick flat	1	.....	Sand	1.65
Ft. Smith, Ark.	3	6 ins. concrete	2	2x3¾x7¾	Sand	.....

a pavement results from (1) the crushing by the wheel load; (2) the abrasion by friction of passing vehicles and the slipping of horses' shoes; (3) the impact due to the passage of loads over a rough surface, and the impact from the shoes of horses. The smoothness of brick will, in the opinion of the writer, more than overcome the difference in abrasive resistance of the granite. The writer estimates the life of first-class brick pavements to be: For light traffic, 35 to 50 years; for medium traffic, 20 to 25 years; for heavy traffic, 10 to 15 years. The smoothness of brick renders it free from much of the objectionable noise of the rougher pavements. Its freedom from decay, and its non-absorption of water, are sanitary qualities of considerable value. It produces little dust of its own, and as it is not retentive of mud and dust, it can be readily cleaned. Being smooth without being slippery, it offers comparatively little resistance to traction, while affording a fair foothold for horses.

Table III gives a concise statement of the manner of laying brick pavements in a number of cities of the United States, which will render the ordinary methods of utilizing this material quite readily understood.

Daniel W. Mead.

CURRENT INFORMATION.

THE OUTLOOK FOR PUBLIC WORK.

In all parts of the country the outlook indicates that public work will be carried forward more extensively this year than at any time heretofore. The city of Philadelphia, which has made such rapid progress in municipal work, has had more street improvements of a permanent character than ever before. More miles of improved paving have been laid, more sewers have been constructed, and more water mains laid than ever before in the city's history. More especially do the newly paved streets seem to urge the need of repaving those streets constructed of cobblestone. The city councils have begun making their appropriations for the public work proposed for this year. A loan of $1,000,000, to be used in street paving is proposed, and several hundred thousand dollars will be expended in the construction of sewers. More miles of newly paved streets were constructed in New York City last year than ever before, and this year will probably find sewers constructed in all of the principal streets of the Annexed District, and a great many more streets paved. The opening and construction of a number of new streets were provided for in a resolution passed December 1. Since January 1, 1893, the aggregate cost of the many miles of finely paved streets of Toledo was more than $500,000, while twelve miles of sewers have been constructed. The work will be further prosecuted this year. During the past five years, Lancaster, Pa., has expended a large sum of money for street improvements, but realized nothing of a permanent character. The city has under consideration now an ordinance providing for a loan of $300,000, to be used for street paving and sewer construction. Three county roads, leading from Omaha, Neb., will be paved in the spring with macadam, stone or brick. The greater part of the sewerage system at Jamestown, N. Y., has been completed, and the attention of the public is now rightly directed to paving, which will begin in the early spring. The preliminary steps have been taken at New Bedford, Mass., for widening Rockdale avenue to a width of eighty feet, thereby securing a boulevard two miles in length. A system of sewers has also been contracted for, to be constructed this year, involving an expenditure of $100,000. An extension of four miles is proposed for the existing boulevard at Lowell, Mass. A practical system of sewerage is planned for Hoboken, N. J., for this year. About thirty miles of newly paved streets were constructed in Pittsburgh, Pa., last year, involving an expenditure of $500,000, and forty-nine sewers are under course of construction, the work of which will continue throughout the winter. The asphaltic paving recently completed in Detroit, Mich., has proven so satisfactory that the residents on two contiguous streets to the one paved are petitioning for asphaltic paving to be constructed this year. Twelve miles of streets were paved

last summer at Dayton, O., and the results realized by business men and citizens alike are so good that plans are taking definite form for paving many streets this year, the work to begin early in the spring. A plan is proposed for constructing an asphaltic driveway between Dayton and Eaton, which will give six miles of continuous asphaltic pavement. A resolution has been passed at Quincy, Ill., providing for the paving of three streets this year with vitrified brick. The three lines will comprise 11,083 feet, and the total cost is estimated at $76,990.05. A street paving project has been started at Los Angeles, Cal. Petitions have been made to the council for the paving of the principal thoroughfare. The General Improvement Commission of Long Island City, created by an act of the legislature last winter, is authorized to spend $1,500,000 in street improvements this year.

And so it is, in all sections of the country, the above mentioned being only a few instances of the projected work for the year. The public has thoroughly awakened to the importance of these improvements, with a determination that indicates a complete transformation, not only in cities and towns, but in the country, where systematic roadmaking is being earnestly advocated and acted upon.

PAVING IN MINNEAPOLIS.

Exception has properly been taken to the heading of an article in the December number of MUNICIPAL ENGINEERING reading "Minneapolis Aldermen Now Favor Brick." The heading was misleading in intimating that the aldermen as a body favored the use of brick, when it was intended to refer to the individual expressions of some of them. The committee which has been investigating the matter of paving for Minneapolis has reported as follows: "The low first cost of cedar pavements, as now laid in Minneapolis, will probably be a stumbling block against the introduction of a more substantial pavement. But considering the facts obtained, and the fact that asphalt and brick, in resistance to traction and in beauty and cleanliness, are away ahead of other pavements, your committee feels inclined to recommend that for the repaving of the down-town streets where cedar blocks are now in use, granite should be put down on the heaviest traveled streets; for instance, Washington avenue and all streets east of the same—asphalt for Nicollet avenue, and brick for Hennepin avenue and some of the cross streets."

PROPOSED ROAD LEGISLATION IN MARYLAND.

The report of the Committee on Legislation, recently approved by the Maryland Road League, divides the state road law into three phases, viz.: The economic, the engineering and the administrative. The economic phase includes questions concerning the following: The amount which may be profitably spent each year on the roads by the state or by counties; the issuance of bonds by the state or counties for road improvements, and to what extent; the division of expenses for constructing and maintaining highways. The engineering side of the question, which involves climatic influences, geological formations, drainage and traffic, is easily solved as far as legislation is concerned. The conclusion is unavoidable, the report says, that this side of the question can not be dealt with by any one but a trained road engineer.

It is suggested that it would be desirable that the state should cre-

ate an engineering department and place its services at the command of the various counties, the latter not to be compelled to commit their roads to the charge of the state engineers, but to thus be given the opportunity to avail themselves of expert assistance. As the duties of such a department would be entirely technical, the committee thinks that it should be under the absolute control of a first-class civil engineer, who should have both power and responsibility. It recommends that he be paid a salary of $5,000 a year; that he be appointed for four years, and that his bond be placed at $5,000. The minimum appropriation necessary for this department is placed at $25,000 annually.

The system of county road administration by supervisors is condemned, and it is recommended that it be abolished.

The committee deems it right that the various county boards should be authorized to call upon the state engineering department for advice and assistance without expense to them, unless they desire surveys made or such work done as would necessitate additional expense to the department. In this way the boards would be furnished with the best possible engineering assistance without any cost whatever. This system was adopted in England under the highway act of 1862, and to its successful working the committee attributes the excellence of England's roads at the present day.

The report declares that it is necessary that the roads should be kept in constant repair and not merely be put in order at wide intervals. To this end it advises that the county boards be encouraged to employ working corps, which should continually keep the roads in repair.

Since such a plan would require money for its promotion, the committee recommends that the right of farmers to "work out" their road taxes be abolished, and that the county boards be directed, under proper restrictions, to have the more important work, such as construction and reconstruction, done by contract and be authorized to contract for repairs with the consent of the county commissioners.

PROVISIONS OF NEW YORK'S ROAD LAW.

A meeting of the Oneida County League for Good Roads was held November 28, in Utica, N. Y., to discuss the need of road improvement and methods for obtaining it. Mr. T. H. Ferris, in speaking of the county option act which was passed last winter, said:

"One minor law provided a rebate of taxes to those using a certain width tire. The county act only affects the supervisors. The present highway system provides for working out the road tax. The county option act provides that when the board of supervisors deems it necessary it shall adopt the county law for their own county. The Oneida county board of supervisors seems to have gotten the idea it must set aside several hundred thousand dollars' worth of road if the act was adopted. This is wrong. The law only says a portion shall be set apart as a county road. A surveyor is then to be elected. The present system is to be done away with and a money system adopted. Some towns are doing that now. If the county road system were adopted the effect would be to have the towns adopt the money system. A portion of the roads can also be set apart to be paid for by the county. The surveyor need have only a small

salary, and the expense on the county would be light."

A committee was appointed to represent the league before the board of supervisors, and secure a hearing, if possible, and to ask every town clerk in the county to inform them of the number of dollars assessed to be paid in cash or worked out as road taxes this year in his town.

The question of wide tires was taken up by Mr. F. H. Gouge, who said that if the question of good roads were to go before the board of supervisors that of wide tires should go with it. He thought the regulation of tires would necessarily follow if good roads were established. The introduction of wide tires would keep the present roads in good condition longer than those now in use, and would prove advantageous even though the county road system were not adopted.

MASSACHUSETTS HIGHWAYS.

The Massachusetts Highway Commissioners gave a public hearing, November 29, at Taunton, Mass., to the discussion of questions relating to public roads. Prof. Shaler, who presided, explained the steps which led to the passage of the law which provides for the establishment of the highway commission, gave some account of the duties of the commissioners, and invited discussion concerning the needs of the county and the condition of its highways. Mr. Shaler stated that there about 20,000 miles of roads in the commonwealth, of which from 2,000 to 2,200 miles are main thoroughfares, which would properly be subject to state control, and it would cost to put them in the order desired about $11,000,000, or about half the cost of the Hoosac tunnel.

The commissioners answered many questions on roads and methods of building, and urged action in the construction of state highways.

GEORGIA ROAD CONGRESS.

The Georgia Road Congress met at Atlanta, November 28. Every congressional district was represented by delegates and many of the most substantial citizens of the state were present. Mr. H. C. Weeks, of Talbot county, presided over the meeting. Ways and means of building and maintaining good highways for Georgia were thoroughly discussed. A paper on road building was read by Captain Henry Hammond, of South Carolina.

ASSOCIATION OF ENGINEERS OF VIRGINIA.

The second informal monthly meeting of the present season was held December 20th, at 8 P. M., the association meeting in the office of the city engineer for convenience of access to plans illustrating the subject for the evening, which was "The Sewerage System of the City of Roanoke." Mr. Wm. Dunlap, city engineer, opened the subject with a paper giving a historical sketch of the city, and of the various plans proposed for the disposal of its sewage and drainage by Mr. R. Hering in 1883 and 1891, by himself in the latter year, and by Messrs. Gray and Hering in 1892. He followed with an account of the work actually accomplished to present date, embracing 59,900 lineal feet of drain of various diameters, from eight inches to thirty-two inches, at a total cost of $60,762, closing with a brief dis-

cussion of the various formulæ and tables in use for determining the size of drains and of the system of ventilation to be adopted. The next informal meeting will be held on Wednesday, January 17th, subject, "Railroad signalling," to be opened by C. S. Churchill; as alternative, discussion on Mr. Dunlap's paper.

L. J. CARMALT, Sec'y.

Roanoke, Va., Dec. 22, 1893.

NOTES OF MEETINGS.

A convention will be held in Indianapolis, Ind., January 2, 3 and 4, 1894, by the Association of Engineers of Indiana.

The annual meeting of the Illinois Brick and Tile Association will be held in Springfield, Ill., January 16 and 17, 1894.

A convention of tile and brickmakers will be held in Indianapolis, January 3 and 4, 1894. A number of important and practical papers will be read, among which are the following: "Farm Drainage," Prof. W. C. Latta, La Fayette, Ind.; "A Glimpse Backward," M. C. Dawson, Rushville, Ind.; "Drainage of Marshes," Wm. M. Whitten, South Bend, Ind.; "Burning Tile," W. E. Dawson, Colfax, Ind.; "Making Large Tile," Samuel Cowgill, Summittville, Ind.

PERSONALS.

Mr. Julian Kennedy, Pittsburgh, Pa., prepared the plans for the Allegheny water supply.

Mr. Desmond Fitzgerald, engineer of the Boston Water Board, was entertained as a guest, December 6, by the Boston Paper Trade Association. Mr. Fitzgerald spoke on "The Water Supply of Boston."

Mr. Charles E. Wise has been appointed general superintendent of the Middletown water-works, Middletown, Md.

The mayor of Bridgeport, Conn., in company with several city officials, visited Baltimore, recently, for the purpose of examining the asphaltic, asphalt block and brick pavements of that city. Granite block paving has been in use in Bridgeport, but objection is made to its noise.

The Shale Brick Exchange, Canton, O., recently entertained Messrs. Percival W. St. George and G. A. Kohl, of Montreal, Canada, who visited the city for the purpose of inspecting the paving brick plants. Mr. St. George is city surveyor of Montreal, and Mr. Kohl represents B. & L. H. Thompson & Co., of that city.

Another catalogue has been issued by Messrs. J. W. Penfield & Son, Willoughby, O., on the subject of their Imperial Friction Clutches. It comprises eighty pages, freely illustrated, and gives a vast amount of information relating to the subject. They offer to assist in securing the most convenient and effective arrangement of plants by furnishing drawings indicating the location of engines, boilers, shafting, hangers, pulleys, etc., if furnished with details as to the machinery to be operated. The new catalogue here referred to treats fully of such matters.

ANOTHER PAVING BRICK PLANT AT GALESBURG.

The St. Louis Paving Brick Company has been incorporated at Galesburg, Ill., with a capital stock of $150,000.

IMPROVEMENT AND CONTRACTING NEWS

PAVING.

The macadamizing of Water street, Trenton, Mo., is completed.

The assessments for paving Pullan avenue, Cummingsville, O., is $6.29 per foot front.

Bucyrus, O., has four and two-fifths miles of paved streets, the total cost of which was $146,000.

By the use of a road roller a great improvement has been made in the streets of Springfield, O.

Much satisfaction is felt in the paving of Western avenue, which was recently completed at Joliet, Ill.

Clearfield, Pa., has about twenty-five blocks of streets paved with vitrified brick, in which they feel a just pride.

During the past season, 23,740 feet of cedar pavements have been constructed in Bay City, Mich., at a cost of $97,310.93.

The paving recently completed at Terre Haute, Ind., in Third, Fifth and Sixth streets, is pronounced very satisfactory.

It is currently reported that Paris is experimenting with mahogany as a street paving material. Its cost is $9 per square yard.

An estimate, amounting to $10,000, has been allowed by the board of public works at Denver, Col., for the West Larimer street paving.

The asphaltic pavements recently completed on Colorado street and Fair Oaks avenue, Los Angeles, Cal., are pronounced very satisfactory.

Several streets are being paved in Huntingdon, Pa. The issuance of bonds, to the amount of $50,000 for that purpose, was favorably voted upon.

Owing to unfavorable weather, it is thought that the paving of East Second street, Edwardsville, Ill., will not be completed until next summer.

The board of public works, in the city of Indianapolis, has approved and accepted the asphaltic pavement on Illinois street. The cost was $47,210.

The new road under course of construction between Newburyport and Malden, Mass., will be one of the most substantially constructed highways in the state.

The city council, Quincy, Ill., has planned its street paving for this year. The streets selected by them will prove a substantial addition to the pavement system of the city.

Charles L. Proda, city engineer at Santa Cruz, Cal., writes that during the month of November, 10,300 square feet of macadam was laid on Pacific avenue, at a cost of 5½ cents per foot.

New Orleans, La., will experiment with brick for roadway paving. The Coaldale Brick and Tile Co., of Coaldale, Ala., recently shipped 300,000 vitrified brick there for that purpose.

The J. T. Wyatt Granite Company, Faith, N. C., has been awarded the contract for furnishing 11,500 square yards of rubble paving stones and 5,000 lineal feet of curbing at Asheville, N. C. for $1,452.81.

George H. Fister, city clerk at Elkhart, Ind., writes that the paving recently completed in Jackson street, is pronounced good and substantial. Paving on Tyler avenue will be held over now until spring.

One of the finest macadamized roads in Virginia was recently completed. It extends from Richmond to Yellow Tavern, a distance of six miles. The suburban parts of Richmond are developing splendid roads, which are a pleasure to the public.

The new Telford road, extending from Moorestown to Mount Laurel, N. J., has been accepted by the county. The total cost of the improvement was $16,000. The contractors, Barbour & Ireland, have begun work on the Church road, the cost of which will be $25,000.

The brick paving recently completed on lower Main street, at Racine, Wis., is the first brick paving that the city has ever had. It gives so much satisfaction, being pronounced the best paving ever done in the city, that it will probably be used in the future street paving of Racine.

Commissioner Schneider, of the board of public works, Milwaukee, is experimenting with an idea of his own, in the Grove street paving, by laying cedar blocks on hard ground instead of planking. He claims that the planks catch and hold water, thereby causing both planks and blocks to decay; while, on solid ground, the water soaks through, leaving the blocks dry and hard.

Cannon steeet, Poughkeepsie, N. Y., recently paved, is a very handsome driveway. 2,589 square yards of brick have been laid, and 1,975 feet of curb has been reset and redressed. The concrete foundation required 600 barrels of Rosendale cement, and 200 barrels of Portland cement were used in grouting the bricks.

Mr. J. E. Davis, Oskaloosa, Iowa, writes that the city expended $44,000 in brick paving last year and will expend fully as much this year. The city's first experience with brick paving was three years ago, and the satisfaction with it has been so general that it will be used in the future. Two and one-fourth miles of streets have been paved, at a cost of $100,000.

An experiment will be made in paving material at Seattle, Wash., by the Denny Clay Co., of that city. The earth will be rolled with a heavy roller, after which eighteen inches of vitrified broken clay pipe will be laid and rolled solidly. On this will be placed, in layers, nine inches of cement, two inches of sand, a layer of vitrified brick and a covering of paver's pitch, put on while hot. The result of this pavement will be noted with great interest in Seattle.

CONTEMPLATED WORK.

Beaufort street, Bloomington, Ill., will be paved with brick.

Fifth street, Sioux Falls, S. D., will be paved with stone block paving.

Kirkham street and Thirty-third street, Oakland, Cal., will be macadamized.

Washington street, Wausau, Wis., has been ordered paved with cedar blocks.

Thorn street, from Front to Water, Wilmington, Del., will be paved with Belgian blocks.

The board of surveyors at Philadelphia, Pa., have approved plans for improving a number of streets.

A movement is on foot at Jeffersonville, Ind., to borrow $5,000 for the purpose of repairing the streets.

The common council of Brooklyn, N. Y., contemplate paving Dean street with cobble stone pavement.

The citizens of Laurel, Md., are discussing plans for the proposed macadamizing of the streets of that town.

D, C and Seventh streets, and Pennsylvania avenue, Los Angeles, Cal., will be paved with soft limerock cement.

Plans and specifications are being prepared at Woodbury, N. J., for the proposed construction of a Telford road on the Main street of Swedesboro. If this road is built petitions will be presented to the Gloucester County Board of Freeholders for more Telford roads in the county.

A resolution has been offered at Marinette, Wis., to have the city engineer prepare plans and make an estimate for paving Pierce avenue.

Ordinances were recently passed at Pleasant Ridge, O., providing for the improvement of Auten street, Mound avenue and Woodford road.

It has been ordained by the board of legislation at Cincinnati, O., that Jackson street be paved with brick, from Twelfth street to Canal street.

The city council at Sioux Falls, S. D., has passed resolutions, declaring it necessary to pave, with stone blocks, Fifth street, from Main avenue to Phillips avenue.

The board of public works at Niagara Falls, N. Y., recently resolved to circulate a petition among the people regarding the proposed paving of Main and Fall streets, and giving them a preference in the kind of paving material to be used.

The citizens on James street, Kansas City, Mo., are petitioning the council to repave that thoroughfare. The street is one of the most important in the city, and was paved in 1883. It was the first block pavement constructed in the state.

Mr. W. F. Davis, Bozeman, Mont., writes that the city council has ordered an improvement district for the purpose of paving about 4,000 feet of the main street of that city with the Telford system of macadam, with cut stone curbing and gutters.

Charles L. Proda, Santa Cruz, Cal., writes that $5,000 has been subscribed by private parties for the improvement of the road extending from Santa Cruz to Big Trees, a distance of six miles. Ex-Supervisor Rodgers will be superintendent of construction.

Feasible plans for improving the Farmingdale road in Monmouth county, N. J., are being discussed. A stone road is favored by the majority of those interested. The road is eighteen miles long, and the cost of macadamizing it will be at the rate of $5,000 per mile, or $90,000 for the entire length of it.

O. R. Rauchfuss, city engineer at Joliet, Ill., writes that the city council has ordered specifications as follows: Paving with cedar blocks, Nicholson street, from Oneida to Buell avenue; Oneida street, from the center to the city limits; Exchange street, from the center to the city limits; paving, with brick, Cass street, from Des Plaines river to the city limits, one mile; graveling Bluff street, from Bridge street to the northern city limits, 3,500 feet.

CONTRACTS AWARDED.

The contract for the construction of a Medina block pavement on East and West Main street, Rochester, N. Y., was awarded Whitmore, Rauber & Vicinus, for $92,897.20.

The village council at Pleasant Ridge, Ohio, awarded the contract for improving Ridge avenue, to Finnerty & Company. The Osborn Paving Co. will furnish the concrete curb and gutter.

The contract for paving Ludington avenue, Menominee, Mich., was awarded Nelson & Sanderson, of Marinette, Wis. The contract calls for 12,500 square yards of paving and is to be completed on or before September 1, 1894. The contract price is $11,224.50.

SEWERAGE.

Alliance, O., expended $20,000 in sewers during the past year.

The northwest sewer system in Monmouth, Ill., is completed.

The sewer, extending from the institute for the blind to the river, at Nebraska City, Neb., is completed.

The sewer system recently completed at Bennington, Vt., is eight and one-fourth miles long and cost $27,000.

The sewer system at Herkimer, N. Y., has been constructed in a very substantial and satisfactory manner.

George H. Fister, Elkhart, Ind., writes that the sewers in Grand, Pigeon, High, Franklin, Marion and Harrison streets will be laid over until spring.

Bay City, Mich., had constructed, last season, 3,542 feet of drain brick sewers, at a cost of $6,440.02, and 9,825 feet of lateral tile sewers, at a cost of $4,358.15.

The site selected for the sewage disposal works, at Madison, Wis., is situated on the north side of East Washington avenue and comprises twelve and one-half acres of ground.

The sewer, recently completed on Iowa avenue, Ottumwa, Iowa, is 3,900 feet long and cost $12,000. The masonry is considered very fine and the entire system is said to be one of the best in that city.

The new branch sewer has been completed in Dennis street, Gardiner, Me. The city officials of Gardiner are endeavoring to secure a comprehensive system of sewers before next winter. Their plan now is to take up the Water street main, in a year or so, and build a good and substantial one, at a cost of $20,000.

The large storm water sewer in Muhlenberg street, Reading, Pa., is about completed. It commences at Fifteenth and Muhlenberg streets, runs down Muhlenberg street to Eleventh and empties into the old stone sewer at Culvert street. At each street crossing are four inlets and a manhole, and the sewer is large enough for a man to walk through.

The Brockton sewerage system, Brockton, Mass., under course of construction, is of the downward filtration plan, and is adapted to the limited area of 22 filter beds of about one acre each. The system, which was designed by City Engineer Snow, shows many unique features in the disposition of sewage, and a scientific study of the nature of the soil and its absorbing capacity.

The new system of sewerage which was recently completed in Farmington Center, Conn., is known as the separate system, providing only for the sewerage of houses. It consists of two and one-half miles of vitrified pipe sewer, 8, 10 and 12 inches in diameter, and is provided with automatic flushing tanks, connected with the waterworks, which discharge once each day. The system, which affords sewerage relief in nearly every street in the central part of the town, is giving general satisfaction. The cost of the system is $10,000.

An ordinance was passed by the common council at Millville, Pa., a short time ago, granting a franchise to the Millville Sewage Company, the terms of which require the company to lay ten miles of sewer pipe, giving them the exclusive right to the streets for a term of fifty years, and providing that should the city wish to purchase the system at the expiration of ten years it may do so by paying the cost price of the plant, with cost of maintenance during the ten years, and dividends at the rate of ten per cent. per annum added. In case the price can not be agreed upon, the matter is to be submitted to arbitration.

The trunk sewer system, which is planned for Hoboken, N. J., if built as it is now planned, will be a brick structure, 8 x 4 feet, with flat bottom and oval top. Newark street is the favored thoroughfare for the sewer now, instead of Ferry street, and it will have its outlet alongside the Hamburg steamship piers, where it will be built out into the river, about 400 feet, between the ferry slips and the piers. A subsidiary sewer will be made of the Jefferson street drain, running north and south, which will connect with the trunk sewer at Newark street. All laterals will drain west from the corner of Washington street and east from the hill slopes and meadows into the subsidiary trunk sewer, thence through Newark street to the river. The sewer will cost about $65,000.

CONTEMPLATED WORK.

A system of sewerage is advised for Owosso, Mich.

A sewerage system will be constructed at Hamilton, Ohio.

A surface sewerage system is contemplated for Gonic, N. H.

A system of sewerage is being contemplated at Bridgeton, N. J.

A thorough system of sewerage is contemplated at Vincennes, Ind.

An intercepting sewer, five miles long, is contemplated at Springfield, O.

An extension of Chestnut street sewer is contemplated at Evansville, Ind.

The construction of three sewers is recommended for New Holland, N. J.

Surveys have been made for the contemplated sewer system at Bristol, Conn.

The sewerage system proposed for Janesville, Wis., will cost more than $200,000.

The construction of a system of sewers is contemplated at Fishkill Landing, N. Y.

Plans prepared for new trunk sewers at Ottawa, Ont., estimate the cost at $356,690.

The board of trade, Plainfield, N. J., contemplates the construction of a sewerage system.

A joint system of sewerage is proposed for South Orange, Milburn, Wyoming and Short Hills, N. J.

Sewers will be constructed in Pecan street, from Corry street to Burnet Woods Park, Cincinnati, O.

An appropriation of $2,000 has been made at Harrisburg, Pa., for the construction of a sewer in Muench street.

O. R. Ranchfuss, Joliet, Ill., writes that specifications will be made for constructing sewers in Nicholson, Oneida and Exchange streets.

The common council at Hoboken, N. Y., has recommended the construction of the $100,000 sewer, which was authorized by the legislature.

The board of legislation at Cincinnati, O., has declared it necessary to construct sewers in Mansion Place, Osage and Elberon avenues.

The board of public works at Jamestown, N. Y., contemplates constructing the third section of the Jamestown sewer system in the early spring.

A sewer is contemplated on Willow street, from Shawano avenue, which is to connect with the Hubbard street sewer, at Fort Howard, Wis.

The council, at Oakland, Cal., deems it necessary to construct sewers in East Twenty-first street, East Seventeenth street and Twenty-sixth avenue.

Legislation is being made at Lowell, Mass., for a system of sewerage to relieve that section of the city lying south of Andover street and north of Laurel street—a system of sewerage in ward 6, a sewer extending from Manchester street to Cosgrove street, and sewers in Third avenue and Foster street.

A sewer is contemplated in the Oaklands, Lowell, Mass., which will drain 100 acres of ground. Petitions have also been presented for sewers to be constructed in Forest and Gorham streets.

A special meeting of council was called, December 5, at Seattle, Wash., to take action for the construction of a line of sewers. Three ordinances were passed, providing an expenditure of $50,000, the work to begin immediately.

Ordinances for sewers in Georgia avenue, Fifteenth street and alleys between Indiana and Missouri streets, Banks and Dix streets and Washington and Bartlett streets, were approved, December 7, by the council committee at Toledo, O.

The Commercial Club at New Albany, Ind., have given instructions to the committee on city development, to formulate a plan, and present it to the club for further consideration and action for obtaining the most reliable talent to devise a general system of sewerage for the entire city. This system has been contemplated in New Albany for some months.

A trunk sewer is contemplated on Butternut and other streets in Twelfth and Sixteenth wards, at Rochester, N. Y. This sewer has been considered for some time. The legislature will be asked to enact a law providing for crossing private land along the route of the sewer, and for the collection of assessments from property owners who will be benefited by the improvement.

The proposed sewerage system for the county institutions in the Menominee and Kinnickinnick valleys in Wisconsin is estimated at $280,000. A disposal system, which can be put in for about $100,000, is favored by the supervisors. The system has been discussed for several years, and the state board of health insists that action must be taken, for the two rivers where the sewage now runs, is polluted. An appropriation of $10,000 has been advised, for preliminary surveys and plans.

Two good plans for a trunk sewer have been suggested for the proposed sewerage system at Hamburg, N. Y. One is for a main or trunk sewer running through the center of the village, east to west and emptying into the river near Water Valley. Another plan is for a main sewer to extend through the center of the village, from north to south, and emptying into the river about a quarter of a mile south of the village. The latter plan is less expensive and, if favored, the smaller sewers could easily be drained into it.

CONTRACTS AWARDED.

The contract for building sewers on Wood, South Tenth and South Third streets, Easton, Pa., was awarded Smith & McCormick for $6,405.98.

The contract for constructing sewers in New Britain, Conn., was awarded Engineer McKenzie for $1,649.

The contract for the State street stone sewer, Rochester, N. Y., was awarded Chambers and Casey for $26,465.

The contract for constructing the Main street sewer, Aurora, Ill., was awarded Donaldson Brothers for $23,456.34.

The contract for constructing the sewerage system at Watertown, Wis., was awarded McCann and McLellan, of Ashland, Wis., for $44,461.25. Work of construction will begin the first part of January.

Wm. M. Whitten, city civil engineer at South Bend, Ind., writes that the contract for a trunk sewer in Taylor street has been awarded the South Bend Construction and Improvement Company. The size of the sewer is from 48x60 inches to 90 inches, and will cost from $4.65 to $7.94 per lineal foot. Total cost estimated at $63,678.18.

L. E. Browne, city engineer at Richmond, Ind., writes that bids were received, December 15, as follows: Sewer in alley between Sixth and Seventh streets, 1,500 feet long, average cut eight feet, Fries, Barr & Co., $1.57 per lineal foot, complete; F. W. Rehling, $1.22; W. J. Irwin, $1.45; John O'Neal, $1.09; Timothy Cronin, 98 cents. Sewer in alley between Seventh and Eighth streets, length 1,500 feet, average cut ten feet, five inches, Fries, Barr & Co., $1.77 per lineal foot, complete; F. W. Rehling, $1.73; John O'Neal, $1.58; W. J. Irwin, $1.55; Timothy Cronin, $1.20.

CONTRACTS TO BE LET.

Contracts will be let for the construction of sewers in ten districts at St. Louis, Mo., about the middle of the winter, so that the work may begin in the early spring.

The councils at Reading, Pa., have authorized the city engineer to advertise for proposals for the erection of a sewerage pumping station, including a pump of 5,000,000 gallons capacity. Bids will be considered the first meeting night in January.

WATER-WORKS.

The water-works system at Lititz, Pa., is completed.

The new water-works plant, at Macomb, Ill., is in operation.

The water-works extension, at Rutland, Vt., cost the city about $51,000.

A system of water-works has been completed at McConnellsville, N. Y.

The new water-works have been satisfactorily tested at Middletown, Md.

The reservoir at Mt. Vernon, Pa., is being enlarged to twice its present capacity.

About $15,000 was expended in improving the water-works plant at North Yakima, Wash.

The construction of the water-works system at Auburn, Me., is practically completed.

The new reservoir at Reading, O., has a capacity for 800,000 gallons of water and cost $2,300.

Hariman, Tenn., has purchased thirty-four thousand feet of water pipe for their system of water-works.

The new water-works system of Cohocton, N. Y., has been satisfactorily tested. The system cost $21,000.

The system of water-works, at Belding, Mich., has been completed, and is pronounced very satisfactory.

The last of six lines of pipe for high pressure service is completed at Detroit, Mich. The total cost of the pipe lines is $15,000.

The new reservoir has been completed at Frederick, Md. It has a capacity for 600,000 gallons. Its total cost is about $24,000.

Great satisfaction is expressed by the citizens of North Olean, N. Y., since the completion of the new system of water-works.

The new system of dams along the Meadow Brook, when completed, will give Scranton, Pa., one of the best water supplies in the country.

The material has been ordered for the construction of a new reservoir at Hot Springs, Ark., which will have three times the capacity of the present one. The cost will be $70,000.

The water-works extension, Sault Ste., Mich., is progressing rapidly. Owing to quick-sand, at the entrance to the bay, planking had to be used on either side of the excavation, which retarded the progress of the work.

The construction of the series of reservoirs at Portland, Ore., in which the city's water supply is to be stored, will begin during January. The plan is to secure water from Mt. Hood, thirty-five miles from the city. Five reservoirs will be built, at an expense of $2,500,000.

The water-works system at Cumberland, Md., has been improved by laying seven thousand feet of twelve-inch pipe, more than six thousand feet of eight-inch pipe, about one thousand feet of twenty-inch pipe and a quantity of eight-inch mains. The water mains have been extended to Chapel Hill, the extreme southern portion of the city, and a new boiler, of greater capacity than the old one, has been provided. A new engine, with a pumping capacity of four million gallons, has been contracted for and will be put in operation March 1, 1894.

The annual report of the water board at St. Paul, Minn., shows that the total receipts of the year were $462,442.28, and the expenditures were $449,121.54, leaving a net balance of more than $13,000. The increase in the business of the board during the year of 1893 has been greatly in excess of any previous year.

CONTEMPLATED WORK.

Water-works are contemplated at Boulder, Colo.

Wenona, Ill., is agitating the question of water-works.

A water-works plant will be constructed at Quincy, Ill.

A system of water-works is contemplated at Norman, Kan.

A system of water-works is contemplated at Griswold, Iowa.

Bonds will be issued for new water-works at Kansas City, Mo.

Norwalk, O., will expend $4,000 in repairing the water-works.

A system of water-works is contemplated for Lake Mills, Iowa.

Batavia, Ill., has voted favorably for a system of water-works.

A system of water-works will be constructed at Beeville, Texas.

Laurel, Md., is agitating the construction of a system of water-works.

A system of water-works is favorably contemplated at Colchester, Ill.

The water-works question is again agitating the citizens of Macon, Ga.

The citizens of Colton, Cal., are contemplating a system of water-works.

The estimated cost for the new water-works at La Salle, Ill., is $160,000.

The construction of water-works at Alexandria, Ind., is again contemplated.

Plans have been prepared for a new water-works system at Duluth, Minn.

The citizens at Savannah, Mo., contemplate building a system of water-works.

The citizens of Farmington, Ill., have petitioned for a system of water-works.

An appropriation of $1,500 has been voted for water-works at Onalaska, Wis.

The purchase of three additional pumping engines is contemplated at Pittsburgh, Pa.

The filtration system has been adopted at Allegheny, Pa. The new works will cost $1,975,000.

The citizens of Bath, Me., have again voted in favor of the proposed water-works extension.

Estimates made place the cost of the water-works system contemplated at Ottawa, Ill., at $160,000.

The citizens of East Poultney, Vt., are agitating an extension of Poultney's water-works that will embrace the village.

About $50,000 will be expended on the water-works at Bar Harbor, Me., this year. The pipes will be taken up and relaid.

The citizens of Ligonier, Pa., have voted in favor of water-works. Bonds will be issued and the contract awarded at once.

Etna borough, Pa., has purchased the plant of the Etna Water-Works Company, and will begin making improvements in the spring.

The city council at Platteville, Wis., has made an appropriation to be extended for surveys and estimates for a system of water-works.

Extensive additions will be made to the water-works plant at Clinton, Mo. New machinery, new standpipes, and more new drains will be put in.

The city council at Moundsville, W. Va., has passed an ordinance granting several Pittsburgh capitalists the privilege of erecting water-works in that city. The standpipe system is favored.

An additional reservoir is contemplated at Stamford, N. Y. Surveys and estimates made, place the cost of this improvement at $8,000. The work of construction will probably begin in the early spring.

G. B. Gill, Petersburg, Va., writes that the city council has appropriated $45,000 for additional storage and distributing reservoirs. Work has begun on the dam. The city engineer, John W. Hays, will superintend the work.

Columbus, Ohio, contemplates increasing the water supply at east side station, an increase of the supply at west side station, the purchase of two pumping engines for the west side works, and the purchase of new boilers for the west side station.

An immense reservoir will be constructed at Porter Hill, south of Connellsville, Pa., by the H. C. Frick Coke Company. The reservoir will have an elevation of 200 feet. The pumping capacity of the new plant will be 1,000,000 gallons daily. The cost will be more than $100,000.

The owners of the Watsonville water-works and electric light plant, at Watsonville, Cal., offer the works to the city for $150,000, while a report made places the cost of a new pumping plant at $80,000, with a monthly expenditure of $450 or $500 for maintenance. An election will be held by the citizens to determine which of the two propositions to accept, after which the city will be bonded to pay for the works.

Lansing, Mich., has voted to try a pump for the water-works with a capacity for 5,000,000 gallons.

CONTRACTS AWARDED.

The Chattanooga Pipe and Foundry Company secured the contract for furnishing the water pipe for Evansville, Ind.

The contract for building a new intake crib at the north side pumping station at Minneapolis, Minn., was awarded E. T. Sykes.

U. B. Payne, of Albany, Ore., was awarded the contract for constructing the reservoir of the water-works system at Oakland, Ore. The bid was for $1,370.

The contract for the water-works system at Spokane, Wash., was awarded to H. L. Cooper for $426,277. J. L. Buehner supplies the pumps for $29,600.

The contract for constructing an extensive water-works system at Sague La Grand, Cuba, was awarded J. Warren Lamb, of Cooperstown, N. Y.

The contract for laying the additional pipes for water mains at Lake City, Iowa, was awarded the A. E. Paige Company, of Sioux City. The extension will be 4,000 feet long.

The water board at Bangor, Me., awarded the contract for furnishing castings for repairs to be made on one of the pumps at the water-works station to the Hinckley and Egery Iron Company for $2,500.

The contract for building the new reservoir for the city of Altoona, Pa., was awarded Thomas Collins, of Bellefonte, Pa., for the sum of $156,506. The water legislation at Altoona was begun in 1889.

Contracts were awarded for three lines of mains in the extension of the city water-works at Woonsocket, Dak. Peter McLean secured two contracts and Frank Campbell and J. E. Carpenter were awarded one contract.

BRIDGES.

A draw-bridge is contemplated at Young's bay, Astoria, Ore.

A bridge, 100-foot span, is being constructed at Sugar Lake, Mo.

A new bridge will be constructed on Water street, at Plymouth, Mass.

A new iron bridge with a 100-foot span has been completed near Salina, Kan.

Another bridge is to be constructed across the Mississippi at St. Louis, Mo.

The new bridge over Rock creek on South Pleasant street, Kansas City, is completed.

A bridge will be built over the Little Wabash river at New Haven, Ill., at a cost of $12,000.

The new bridge over Haw creek, near Columbus, Ind., is a good and substantial improvement.

A 150 foot span bridge is under course of construction across the Platte river at Edgerton, Mo.

The contract price for the new iron bridge across Hydraulic avenue, Elkhart, Ind., was $1,520.

Work has begun on the substructure of the new bridge across the Mississippi at St. Cloud, Minn.

A bridge, costing $10,000, will be built near New Castle, Colo., to replace the one washed out some time ago.

The Wrought Iron Bridge Co., of Canton, O., are constructing the new bridge across the Nemeha, west of Bern, Kan.

The citizens of the west side, Youngstown, Ohio, are still confident of securing a new bridge at Spring Common.

The construction of a bridge is contemplated over the Desplaines river, to connect Hollywood and Riverside, Ill.

A bridge will be built over Stranger creek, near Atchison, Kan., by the St. Joseph Bridge Company. It will cost $1,683.

The contract for rebuilding the approaches to the Broadway bridge at Milwaukee, Wis., has been awarded to J. E. Hathaway.

The county commissioners will re-advertise for bids for the construction of a bridge over the river at First street in the city of Indianapolis.

The iron bridge across Henley creek, near Huntingburg, Ind., is completed. It was built by the Wisconsin Bridge Company for $525.

The work on the Olive street bridge, Spokane, Wash., is about completed. It is thought the bridge will be open to travel by February 1st.

The contract for the superstructure of the new St. Germain street bridge, St. Cloud, Minn., was awarded the Penn Bridge Company for $26,150.

A bridge, sixty feet long, will be constructed across Prairie creek, in South Fork township, near Maquoketa, Ia., by the Clinton Bridge Co., for $707.

The contract for rebuilding four bridges was awarded, at Oakland, Cal., to Cotton Bros., as follows: Bridge No. 1, $215; No. 2, $195; No. 3, $174; No. 4, $147.

The two iron bridges erected over Mud creek, near Aberdeen, S. D., have been approved. J. G. Bullen & Co., of Ashland, S. D., who had the contract, received $476 for each bridge.

The largest wagon bridge in California is the one recently completed over the Yuba river between Marysville and Yuba City. The cost of the bridge was $18,000.

Bids will be received until January 9, 1894, for building a bridge across Martin's creek, near Elden, P. E. I. Address John Wm. Morrison, secretary of public works.

Sealed bids will be received by John N. Morrison, secretary of public works, Charlottetown, P. E. I., until January 20, 1894, for rebuilding Doyle's bridge across Little Tignish Pond.

The iron bridge across the bayou Lafourche at Napoleon, La., is completed. It is pronounced a fine piece of work, and a great improvement and convenience to travel and traffic.

The county commissioners at Atchison, Kan., awarded ten contracts for the construction of bridges December 5th. The Chicago Bridge and Iron Company secured most of the contracts.

An appropriation of $500 has been made by Pierce county towards the construction of a new bridge across Rush river near Maiden's Rock, Wis. It will be known as the Warrenton bridge.

The plans for the "Sixth Bridge," which will be constructed at Cincinnati, O., provides for separate roadways for vehicles and electric cars and two sidewalks. The bridge will cost about $2,500,000.

The Kramer bridge, under course of construction near Preston, Minn., will be one of the finest in the county when completed. It will be the fourth bridge constructed in the county within a very short time.

The old wooden bridges are being torn down across the various canals, intersecting Canal street, New Orleans, La., and are being substituted by solid brick and masonry coverings, supported by heavy steel girders.

An abutment is being constructed for the Factory street bridge at Springfield, O., at a cost of $7,500. The Lagonda avenue bridge, completed in October, at a cost of $7,700, is a handsome and substantial structure.

The new iron bridge over Prairie Creek, near Ionia, Mich., is completed, and proves satisfactory. It was put up by S. S. Ramsey & Co., of Portland, Mich., agent for the Canton Bridge Company. The cost of the bridge was $498.

George H. Fister, city clerk at Elkhart, Ind., writes that a new iron bridge is being erected over the Hydraulics in that city. The bridge is eighty feet long, and will cost, complete, about $3,000. A small iron bridge is also being constructed over the Race on East Franklin street, at a cost of about $1,800.

The contract for building a new iron bridge across Oak creek, near Cawker, Kan., was awarded the Geo. C. King Bridge Co., of Des Moines, Ia. The bridge is 16 feet wide, 78 feet long, with an 18-foot wooden approach.

The commissioners of Matagorda county, Tex., recently contracted for three new suspension bridges and one wooden bridge, to be constructed in the county, making eight first-class iron bridges constructed in the last three years.

The Wrought Iron Bridge Company, Canton, Ohio, secured the contract for the iron work of a bridge which will span the Sac river, near Ash Grove, Mo. The contract for the masonry and approaches was awarded T. J. Bearden.

The plans for the bridge to be constructed on the new Box Springs road provide for a triple span, the spans at each end being 47 feet long, and the middle span 60 feet long, making a total of 184 feet. The bridge will be 20 feet wide.

The county commissioners at Denison, Tex., awarded the contracts for two iron bridges, recently, one across the Sandy creek, near Gordonville, 90-foot span, and costing $2,195; one across Raine's creek, 70-foot span, and costing $1,700.

J. E. Davis, civil engineer, Oskaloosa, Iowa, writes that the iron bridge across the Des Moines river is completed. It is a four-span bridge, each span 156½ feet long, which rests on tubular piers six feet in diameter, and with sixteen feet of roadway. The total cost was $18,500.

The county commissioners, Yankton, S. D., have advertised for bids for a new iron or steel bridge across the James river, to replace a condemned structure that is there at present. The new bridge will be 300 feet long, and will be of the single truss pattern, with concrete and stone foundations.

The new bridge over the Big Sioux, five miles east of Elk Point, S. D., is completed. The span of the bridge is 150 feet, and was built by S. M. Hewett & Co., of Minneapolis, Minn. The structure is pronounced solid and substantial. It was built by the farmers, who made up a subscription of $1,200.

The bid of the Fitz Simmons and Connell Company for the construction of the abutments of the new Van Buren street bridge in the city of Chicago was the lowest received. The type of the bridge is an unusual one in this country, although common in the old country. There will be no center pier, and the machinery and power for swinging or raising the two parts of the bridge is to be located in the abutments. The Fitz Simmons and Connell Company offer to furnish the material and do the work for $74,120.98.

The contract for the Port street bridge, in Spokane, Wash., was awarded the San Francisco Bridge Company, for $15,755, the work to be completed by March 4, 1894. The bridge will be an all steel truss, with but one span, 248 feet in length. The approaches will make the total length of the bridge 400 feet.

Six new iron bridges are under course of construction in Vigo county, Ind. The Massilon Bridge Co. is building bridges at Riley, Lost Creek, Pimento, and one four miles south-east of Riley; the Kink Bridge Co. is building a sixty foot bridge over Little Sugar creek on the Paris road, and the Variety Iron Co. is building one near the Ryan farm on St. Mary's gravel road.

Sealed bids will be received, until January 15, 1894, for building an iron or steel bridge over the Jefferson slough, near Three Forks. Length of main span, 110 feet, to be built on iron tubular piers, 17 feet long; width of roadway, 16 feet; length of pile approach on north end, 162 feet, together with the necessary grades at each end. Address, B. E. Vaill, county clerk, Bozeman, Mont.

STREET RAILWAYS.

The street railway at Marion, Ind., is being extended to Jonesboro.

An electric railway is proposed between Windsor and Amherstburg, Ont.

The electric railway was put in operation at Portsmouth, Ohio, in November.

The motor line at Wauwatosa, Wis., will be converted into an electric line in the spring.

An electric railway will be built between Bridgeport and New Haven, Conn., by the West Shore Electric Railroad.

The Brooklyn City Railroad Company has been granted permission to operate by the trolley system in a number of streets at Brooklyn, N. Y.

It is thought that matters will take a definite shape in the spring regarding the grand boulevard and electric railway proposed to connect Baltimore, Md., and Washington, D. C.

The new company which has purchased the Freeport City Street Railway, Freeport, Ill., will convert the present system into an electric system. Eight miles of electric road will be constructed and operated at once.

A meeting was held in Cleveland recently by the capitalists interested in the proposed electric air line between New York and Chicago. The plans prepared prove the scheme a feasible one. The estimated cost of this line will be $1,000,000.

The Alexandria, Va., city council has granted a franchise to the Washington, Alexandria and Mount Vernon Railway Company, giving them the right to pass out of the city by either King, Cameron or Payne streets, so that a track may be run north or west.

A new corporation has been organized at Columbus, Ohio, which will be known as the Columbus Central Railway Company, to build an electric railway between Columbus and Westerville. The system will embrace twenty-six miles of track in the city and twelve miles in the country.

Luther Dean, Taunton, Mass., writes that the board of aldermen granted the Taunton Street Railway Company a location on Winthrop street, from Highland street to Westville, a distance of 6,600 feet, and on School, Winter and Washington streets, to Bay street, a distance of 12,300 feet.

About seventy representatives of New Hampshire towns met at Haverhill and discussed plans and pledged financial support to any electric road that would open up these towns. A corporation will be organized preparatory to obtaining a franchise from the New Hampshire legislature. Two lines have been planned, so far, from Haverhill—one via Atkinson, Hampstead, Chester and Derry to Manchester, and the other via Ayer's Village, Salem, Walnford and Hudson to Nashua—including, in are more than sixty miles of electric road. Haverhill capital will be invested, and every town interested has made offers for stock.

STREET LIGHTING.

Electric lights are proposed for Edinburgh, Ind.

The streets of Romeo, Mich., will be lighted with electricity.

The city council at Elkhart, Ind., are contemplating an electric light system.

A franchise has been granted Mr. E. Lawrence to put in an electric light plant at Greenville, Ind.

Mr. C. A. Morey writes that bids will be received, early in February, for lighting the city of Winona, Minn., with arc lights or gas.

Lawrence, Mass., contracted with the Lawrence Gas Company for 415 12-o'clock incandescent lights at $1.50 per month; 117 all-night incandescent lights at $2.25 per month; 96 all-night full arc lights at $8.33⅓ per month; 49 all-night divided arc lights at $7.50 per month.

PUBLIC PARKS.

A public park is proposed at Stockton, Ill.

The city of Winona, Minn., will expend $4,000 in improving and beautifying Central Park next spring.

The board of trade at Malden, Mass., is urging the need of acquiring lands for the purpose of creating parks.

The park commissioners at Denver, Colo., are considering the purchase of Broadway Athletic Park for city park purposes.

A proposition is under consideration at Detroit, Mich., for converting the old reservoir grounds into an elevated park.

A park will be fitted up at Spring Valley, Minn. Nice driveways will be constructed, a fountain placed in the center and trees planted.

Sixty acres more of land will probably be added to Lincoln Park, Chicago, Ill. If the plans which are contemplated now are acted upon, the project will cost about $2,000,000.

The park commissioners at Cleveland, O., have been seeking a desirable location for a big park for some time, and it is now probable that a site will be chosen in Newburg, where the natural advantages offered make it a fine location.

A tract of ground, containing three acres has been purchased at Davenport, Ia., for a new park. It is favorably situated, and is considered the most desirable piece of ground in the city for park purposes. Improvements will be commenced at an early date.

A piece of land has been given the town of Libertyville, Ill., for a park, and the citizens and village board intend making it one of the finest parks in the county.

A park is being contemplated at St. Louis, Mo. The instigator of the movement is Mr. Leslie Moffett, who wants a bill introduced authorizing the city to purchase the block of ground on the north side of Market street opposite the Union Depot and make a park of it.

MUNICIPAL BONDS.

Bids are invited, until January 9, 1894, for the purchase of bonds of the village of Delhi, O., aggregating $2,867.86.

The common council, Duluth, Minn., invites bids, until January 8, 1894, for the purchase of "water and light bonds" to the aggregate amount of $800,000.

Bids are invited, until January 9, 1894, for the purchase of $60,000 of water-works and electric light bonds of the city of Napoleon, O. Address, C. E. Reynolds.

Sealed bids are invited, until January 11, 1894, for the purchase of $300,000, four per cent., city of Cleveland park bonds. Address, C. H. Bulkley, president board of park commissioners.

Sealed proposals will be received, until January 4, 1894, at Milford, O., for the purchase of the following bonds: Ten bonds of $37.22 each, High street; ten bonds of $97.95 each, Mill street: ten bonds of $177.90 each, Main street, South Milford; ten bonds of $173.72 each, Mound street; ten bonds of $81.15 each, Main street, to bear interest at the rate of six per cent. per annum.

PUBLIC LIGHTING PROPOSALS SOLICITED.

Sealed proposals are solicited for furnishing the city of Winona, Minn., with gas or electric lights for street lighting, for the periods of three, five, seven or ten years, as follows:

1st. With arc or incandescent lamps, or both.

2d. With gas.

3d. With arc or incandescent lamps, or both and gas.

4th. With arc or incandescent lamps, the city to have the option of purchasing the plant complete after two years, the city to furnish the site.

5th. For furnishing a plant for lighting the city with arc or incandescent lamps, or both, the city to furnish the site, building and power. Plant to be completed July 1st, 1894.

The above proposals are to be made on a basis of 240 maximum and 150 minimum arc lights of 2,000 candle power each, or their equivalent. Bidders to state in their proposals the earliest possible date when they will be able to furnish light under their contract. Bids in all cases to be made separate for different schedules, and all plans and specifications to be either made by the city engineer or submitted to him for his approval not later than February 1st, 1894.

Each proposal must be accompanied by a certified bank check for $1,000, which said check must be made payable to O. H. Clarke, city recorder, and deposited with him as a guarantee that the successful bidder will enter into a written contract with said city in accordance with his said bid.

The successful bidder will be required to enter into a written contract with said city within ten days after the award of contract by the city council, and in case of failure of the bidder so to do, the check so deposited with the recorder shall be forfeited and become the property of the city of Winona absolutely. Proposals will be opened at a regular meeting of the city council of said city, to be held February 11th, 1894, at 7:30 o'clock P. M., the city reserving the right to reject any and all bids.

Address proposals, etc., to

O. H. CLARKE, Recorder,
Winona, Minn.

NOTICE OF THE SALE OF BONDS.

Sealed bids will be received at the office of the city auditor, Cleveland, Ohio. until 12 o'clock M., January 11th, 1894, for the purchase of $300,000 4 per cent. city of Cleveland park coupon bonds, maturing October 1, 1923. These bonds draw interest from October 1, 1893, and will be issued under due authority of law and resolution, both principal and interest being payable at the American Exchange National Bank in New York city, interest payable semi-annually. A certified check, drawn on a national bank for 5 per cent. of the amount of bonds bid for, and payable to the order of the treasurer of the city of Cleveland, must accompany each bid. No bid will be entertained unless made on a blank form which can be obtained on application to the city auditor or board of park commissioners. No bid for less than par and accrued interest to the day of delivery will be accepted. Bonds to be delivered to buyer at Cleveland. The bonds are of $1,000 denomination. C. H. BULKLEY,

President Board of Park Commissioners.

BIDS FOR SIDEWALK IMPROVEMENTS.

HOUSTON, TEXAS.

This city will receive sealed proposals for the improvement of sidewalks as per resolution duly passed by the city council December 4th, said improvements to be done according to specifications on file in the city engineer's office. Said sidewalks to be constructed on the following named streets, or portions of streets, where good and sufficient sidewalks do not now exist, to wit: Travis street, from Congress avenue to Capitol avenue; Milam street, from Congress avenue to Rusk avenue; Louisiana street, from Congress avenue to Rusk avenue; on the west side of Main street, from Congress avenue to Rusk avenue; on the west side of Milam street, from Rusk avenue to Holman street; on the west side of Louisiana street, from Rusk avenue to Holman street.

Sealed proposals will be received at the office of the city secretary until 12 o'clock M., January 8, 1894.

Bids will be received for stone, cement, or hard burned brick.

Proposals for the work must be addressed to the city secretary, and must be endorsed "Bids for Sidewalk Improvements," and the bid must name the streets on which the sidewalks are to be constructed.

Specifications for the above work can be seen at the office of the city engineer.

Bids must be accompanied by a certified check of $250 to secure the execution of the contract.

JNO. T. BROWNE, Mayor.

NOTICE TO STREET CONTRACTORS.

1. Notice is hereby given that the common council of the city of Brazil, at their regular meeting, to be held in the council chamber, on Tuesday evening, the 6th day of February, 1894, will receive sealed proposals until 7 o'clock P. M. of said day for the improvement of Main street from Meridian street to Center street, a distance of about eight hundred feet.

2. Said improvement to consist of grading, covering with crushed stone, curbing and paving with vitrified brick said street between the above named points.

3. Each proposal must state the price per linea foot for which said improvement will be made.

4. Bids must be made out on blank forms to be furnished by the city clerk, and must be accompanied by a bond in the sum of $500.

5. The price bid is to cover the furnishing of all material entering into the construction of said work, and the necessary labor and tools required to perform the same, in accordance with the plans and specifications adopted for said improvement and now on file in the office of the city clerk.

6. Said work is to be done so as to conform to the established grade for said street, and under the immediate supervision of the city civil engineer, and shall be subject to his approval.

7. The common council reserves the right to reject any or all bids should they deem it for the best interest of the city.

By order of the common council.

JOHN MACDONALD, City Clerk.

December 27th, 1893.

BRIDGE LETTING.

Sealed proposals will be received at the office of the undersigned, in the city of Bozeman, county of Gallatin, state of Montana, until January 15th, 1894, at 10 o'clock A. M., for the building of one iron or steel bridge over the Jefferson Slough, near Three Forks, of the following dimensions, viz.:

Length of main span 110 feet, to be built on iron tubular piers 17 feet long, width of roadway 16 feet, length of pile approach on north end 162 feet, together with the necessary grades at each end.

Bridge, approach and grades to be completed, ready for travel in accordance with specifications on file in my office. Bidder to furnish plans, specifications and strain sheets for main span. Certified checks, payable to the order of the undersigned for ten per cent. of bid, to accompany each proposal. Same to be forfeited to Gallatin county should successful bidder fail to enter into contract and give required bond.

The successful bidder will be required to enter into a written contract, binding himself to construct said bridge in accordance with plans and specifications, and to give a bond with local sureties in a sum double the contract price, conditioned for the faithful performance of said contract. The right to reject any or all bids reserved.

By order of the board of commissioners.

B. E. VAILL, County Clerk.

SOME OF MANY COMMENTS.

INTERESTS THE BRICK CONTRACTORS.

COLUMBUS, O., Jan. 12, 1893.

Editor Paving and Municipal Engineering:

DEAR SIR—The January number of your Journal received. Am greatly pleased with its new form and dress, consider it the best magazine published on the topics it embodies, being full of timely hints and articles of value bearing on my business, which is brick street paving. But this is not the only part that interests me, for I read its entire contents and profit thereby. Yours truly, F. W. CERNY.

A WORK OF ART.

RED WING, MINN., Jan. 13, 1893.

Your magazine certainly is a work of art and does great credit to your institution and to the cause it advocates.

Yours truly,
RED WING SEWER PIPE CO.,
C. E. SHELDON, *Sec'y.*

WHERE IT HAS HELPED.

WINONA, MINN., Jan. 12, 1893.

We esteem your periodical highly and it has been of much value to us in reaching a conclusion upon paving, which we are about to enter upon here.

Yours truly, C. A. MOREY,
Chairman Com.

A MODEL NUMBER.

OMAHA, NEB., Jan. 12, 1893.

Please allow me to congratulate you on the January number of "PAVING AND MUNICIPAL ENGINEERING." It's a model number and I trust that the same excellence will be maintained.

Very truly yours,
JOHN GRANT, *Pres.*
Grant Asphalt Paving and Slagolithic Co.

MAY IT LIVE LONG AND PROSPER.

PULLMAN, ILL., Jan. 12, 1893.

I am much pleased with "PAVING AND MUNICIPAL ENGINEERING," in its new dress. May it live long and prosper. WILLIAM LEE.

INTERESTING TO MUNICIPAL ENGINEERS.

BAYFIELD, WIS., Jan. 13, 1893.

The new form is truly a great improvement over the other form. All who are engaged in municipal engineering will hail with delight the contributions found therein. D. F. GLOVER.

THE GENERAL VERDICT.

BINGHAMTON, N. Y., Jan. 12, 1893.

I am much pleased with "PAVING AND MUNICIPAL ENGINEERING." It is very interesting and instructive. Very truly yours,
S. E. MONROE, *City Engineer.*

INTERESTED IN PAVING BRICK.

MT. VERNON, O., Jan. 14, 1893.

I am well pleased with its appearance and as brick paving has come to stay, I eagerly devour all that is calculated to throw light on that subject.

Very respectfully, A. CASSIL, *C. C. E.*

APPROVED IN ALL RESPECTS.

PHILADELPHIA, PA., Jan. 13, 1893.

The January number of your Journal in its new form meets with our approval in every respect. It is much more attractive and convenient than the old form and we think you will undoubtedly find it a step in the right direction. Wishing you success. Yours truly, CHAMBERS BROTHERS CO.,
J. H. CHAMBERS, *Gen'l Mgr.*

WILL CONTINUE TO READ IT.

MANKATO, MINN., Jan. 13, 1893.

I have received your Journal for some two years and in its new form shall continue to read it.

Truly yours, M. B. HAYNES, *City Engineer.*

THINKS IT A GREAT IMPROVEMENT.

MINNEAPOLIS, MINN., Jan. 14, 1893.

Your handsome monthly in the new form is received. We think it a great improvement on the old style, and the editorial and contributed articles are interesting and valuable for preservation, and in convenient form for binding. Wishing you a large success, we remain, yours truly,
PARKHURST PAVING CO.

BRIEF, BUT GRATIFYING.

TROY, N. Y., Jan. 12, 1893.

We congratulate you.
OSTRANDER FIRE BRICK CO.

LIKE ITS NEW STYLE.

BOSTON, MASS., Jan. 13, 1893.

We are pleased with its "new garments" and typographical arrangement.

POPE MFG. CO.

WILL BE OF MUCH USE.

MOBILE, ALA., Jan. 12, 1893.

It strikes us that you made a great improvement in your magazine and we believe it will be of much use to all parties interested in municipal work.

Yours truly,
IMPROVED WOOD PAVEMENT CO.,
By A. C. DANNER, *President.*

EVEN THE ADVERTISEMENTS ARE IMPROVED.

PHILADELPHIA, PA., Jan. 16, 1893.

To say there is a decided improvement in your magazine is putting it very mildly indeed. The specimen cover published in your December issue was evidence to me of a great improvement in form and taste; to me it is very taking. I was not prepared, however, for the improvements in the inside arrangements. Why, everything is improved—even the advertisements. To tell you all I think about it would seem fulsome. I really am much pleased with it and as to suggesting improvements, why, you have not left me an inch of room.

Yours truly, WILLIAM WAPLINGTON.

CALLS THE ATTENTION OF COUNCIL TO IT.

BOONE, IOWA, Jan. 16, 1893.

I think it just the kind of periodical needed by parties interested in that kind of work, and shall call the attention of the City Council to the matter at its next meeting. Respectfully,
W. W. HIXON, *City Clerk.*

A GREAT IMPROVEMENT.

NEW YORK, Jan. 17, 1893.

New form is great improvement. By judicious selection of best information on construction and maintenance of different kinds of road pavements—Europe is a very important source from which to draw—your paper could become the recognized authority on that subject in America.

Yours truly, RUDOLPH HERING,
No. 277 Pearl St.

MORE CONVENIENT FOR REFERENCE.

MICHIGAN CITY, IND., Jan. 11, 1893.

I like the new form much better than the old as it is more convenient for binding and keeping for future reference. Yours, etc., H. M. MILES,
119 E. 9th St.

ONE OF THE BEST.

FOSTORIA, OHIO, Jan. 17, 1893.

The magazine needs no suggestions to improve it as it already is one of the best published and the form is the best. Yours very respectfully,
FRANK GEBERT.

LIKES THE BIOGRAPHIES.

EVERETT, MASS., Jan. 15, 1893.

I am very much pleased with "PAVING AND MUNICIPAL ENGINEERING" in its new form, especially the short biographies of contributors.

Yours, etc., GEORGE L. MIRICK.